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CableLabs

Cable Television Laboratories, Inc.

Stephen D. Dukes
Vice President, Advance Network Development

April 30, 1993

Dr. Thomas P. Stanley
Chief Engineer
Federal Communications Commission
2025 M Street, NW
Washington, DC 20554

Dear Sir,

PCS Experimental License KM2XAT
Your File 3034-EX-PL-92

Our third quarterly report, covering the period ended March 31st, is attached.

Yours truly,

Stephen D. Dukes

cc: Richard H. Strodel

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CABLE TELEVISION LABORATORIES, INC.
PCS EXPERIMENTAL LICENSE
THIRD QUARTERLY REPORT

GENERAL

This is the third quarterly report by Cable Television Laboratories, Inc. (CableLabs), under experimental license KM2XAT, covering the period ended March 31st, 1992.

This license was awarded by the Federal Communications Commission (FCC), effective June 10, 1992 and expiring January 1, 1994. A copy of this license was included in our first quarterly report.

CABLELABS' INTEREST IN PCS

CableLabs is a research and development consortium of North American cable television operators. Its members provide service to 85 % of the cable television subscribers in the U.S.A. and 60 % of those in Canada. Among its members are the leading cable television operators in these countries.

Many CableLabs members are looking into the prospects for providing PCS (personal communications services) on cable. Some of these members are holders of experimental licenses from the FCC. In addition, CableLabs members are associated with all three of the non-telco commercial Digital Cordless Telephony licenses in Canada. CableLabs' research and development program supports members who have an interest in PCS.

One of the programs at CableLabs is the investigation of the integration of cable and radio technology to provide PCS. It seems likely that, by making use of the pre-existing broadband cable infrastructure which cable operators have in place in many localities, PCS could be brought to the public readily and economically.

CableLabs is using portions of the radio spectrum to evaluate and demonstrate PCS radio technologies in a cable environment.

ACTIVITIES COVERED BY THIS REPORT

The following activities are covered in this report:

1. Microcell extender evaluation.
2. PCS in daily use.
3. Space Diversity Using Distributed Antennas
4. Loans of Equipment to CableLabs Members
5. Preparations for Future Activities

Microcell Extender Evaluation

In Appendix A of our Second Quarterly Report is described the method which was used for evaluating Microcell Extender (MEx) technology compared with Remote Antenna Driver (RAD) technology. Both technologies are of interest to the cable industry, so there is interest in knowing if there are any practical differences.

The measurements were made in the Metrotown Centre enclosed atrium-style shopping mall in Burnaby, B.C., which is a Rogers Cablesystems test bed. CableLabs-provided MExs were located at two locations where Rogers had previously performed RAD experiments. Radio coverage measurements were made using the methodology and data point locations which Rogers had used, so as to provide a basis for comparison.

This experiment showed that:

-- Received signal level alone is not a sufficient indicator of subjective voice quality.

-- The range of variation of received signal levels at a given location is not in itself a sufficient indicator of subjective voice quality.

-- Performance in the overlap zone between adjacent simulcasting remote antennas was similar, whether with RADs or MExs. A performance degradation of up to one grade, on the 5-grade scale of Table 1 below, was observed in the overlap zone. The performance degradation is the result of interference between rays from the adjacent remote antennas. The resulting quality in the test was still "very good".

-- The development of simple test systems and methods to reduce the subjective component of determining coverage quality is very desirable (CableLabs has a research program directed toward these ends).

Table 1
Subjective Audio Quality Rating Scale

RATING	SUBJECTIVE QUALITY
5	Excellent audio (toll grade or better) with no audible impairments.
4	Very good audio quality with minimal impairment.
3	Consistent radio coverage. Audio is usable with moderate impairment (periodic "clicking" due to audio muting when the Bit Error Ratio on the radio link exceeds 10^{-3}).
2	Marginal radio coverage. Audio is listenable but requires frequent repetition.
1	No radio coverage (includes cases where link drops).

PCS in Daily Use

Two CableLabs staff members began regular daily use of CT2 equipment in CableLabs' office, in order to acquire a hands-on appreciation of transmission quality issues.

During January and February, operations took place at in the 1921.1-1927.9 MHz band. Beginning in February, operations were shifted to the 902.1-906.1 MHz band.

In each case, a Motorola CT2 private base station was set up in a location which provided coverage of the user's typical work area. CableLabs' offices are on the 4th and 5th floors of a 5-storey building at 1050 Walnut Street, Boulder, and one user was selected on each of the two floors. The base station configuration adopted was: one base on the 4th floor, for the 4th-floor user, and one on the 5th floor, for the 5th-floor user.

Although good coverage was obtained in the vicinity of the users' work stations, and some adjacent-floor coverage resulted, in neither case was a single base station adequate to cover the entire CableLabs establishment on both floors, due to the attenuation of partitions, floors, and other objects.

Distributed antenna systems (such as Remote Antenna Drivers, Microcell Extenders, leaky coaxial lines, and even simple multiple-fed antennas) are possible means of providing coverage of the entire CableLabs establishment, and some of these will be studied.

These operations took place without the use of diversity. Future work will investigate the impact of space diversity on this coverage area.

A very important outcome of these experiments is the significant improvement in business efficiency that resulted. Among other things, the test users were able to answer in real time a noticeable amount of incoming calls that might otherwise have gone to voice mail when the test users were away from their work stations.

This daily-operation trial will be extended to other CableLabs staff members. CableLabs commends to readers of this report the usefulness of such a daily-operation trial in their own circumstances, for the insights it could convey.

Space Diversity Using Distributed Antennas

CableLabs sponsored experiments of space diversity using distributed antennas during the week of March 22, 1993. The experiments are summarized in Appendix A.

Loans of Equipment to CableLabs Members

During the week of February 8th, CableLabs loaned a 1.9-GHz CT2 private base station and handset to Cox Enterprises, for use by them in El Cajon, CA, under their experimental license KF2XFR expiring December 31st, 1994. They used the equipment for propagation observations. A CableLabs representative was also very kindly invited to witness some of the experiments they were performing, on February 10th, and made brief observations of transmission quality using CT2 and Omnipoint equipment. The activities will be reported to the FCC by Cox.

Also during the month of February and into early March, CableLabs loaned a 1.9-GHz CT2 Telepoint and handset to Cablevision Systems Corporation, for use by them in Lynbrook, NY, under their experimental license KF2XFX expiring January 1, 1995, and under their control. They used the equipment for propagation observations and in

connection with Remote Antenna Driver technology. The activities will be reported to the FCC by Cablevision.

Other equipment loans and exchanges with CableLabs members are also under discussion.

Preparations for Future Activities

Motorola CT2 CAI equipment operating at 864, 902 and 1921 MHz has been received. Northern Telecom CT2Plus Class I equipment, operating at 864 MHz has been received.

The rework of CableLabs' RASP and RAD equipment to include equipment updates that were suggested by the experience of other CableLabs members to date, and to operate at 902-906 and 1921-1928 MHz, was in progress at the end of the first quarter of 1992. This will enable comparisons to be made of the differences in RAD behavior in the two bands.

Two Nexus 900-MHz microcell extenders, and a microcell extender base unit, have been received and are being set up to cover CableLabs' offices.

Progress was made by Enterprise Technologies (formerly Nexus) on CableLabs' order for a CT2 base station and RASP which will accommodate very long base-handset delay times. This will demonstrate that the cable distance limitation of TDD (time-division duplex) radio technology can be overcome, by making use of the FDD (frequency-division duplex) characteristics inherent in the cable plant.

SUMMARY

The activities to date by CableLabs and others continue to indicate that cable technology is suitable for the economic provision of PCS.

APPENDIX A
SPACE DIVERSITY USING DISTRIBUTED ANTENNAS

Introduction. -- CableLabs sponsored an investigation into space diversity using distributed antennas during the week of March 22, 1993.

Space diversity can give significant gains in coverage when individual antennas are used that are directly connected to a base station. CableLabs wanted to know what the effect would be in a microcell environment using single and multiple remote antennas. The evaluation focused on comparing the performance of individual remote antennas with and without space diversity, and the performance in the overlap zone between two simulcasting remote antennas.

Test Setup. -- The experiments took place in Lynbrook, NY, under Cablevision Systems experimental license KF2XFX expiring January 1, 1995. CableLabs was responsible for defining the test objectives and procedure, and managing the experiments. Rogers Engineering provided engineering expertise by arrangement with CableLabs. Cablevision Systems Corporation, Rogers Engineering, Enterprise Technologies (formerly Nexus Engineering) and CableLabs all contributed equipment for the tests. Cablevision Systems provided the venue for the tests, including coaxial cables on which to configure the distributed antennas, and contributed human resources for the tests.

In the tests, a CT2 CAI base station capable of space diversity was set up in the headend, and was used to drive microcell extenders at two remote locations on the east side of Ocean Avenue, as outlined in Figure A1.

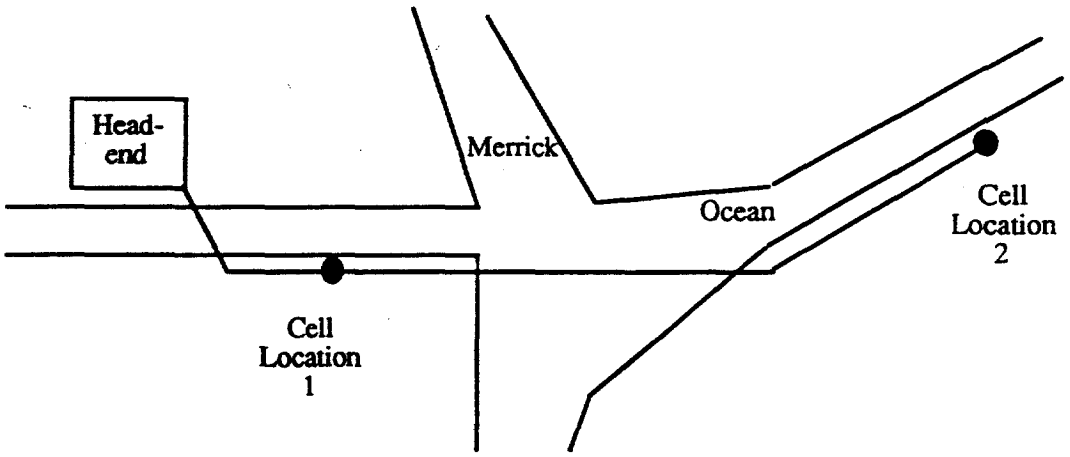

Figure A1. -- Distributed antenna layout.

Two parallel paths were provided, as outlined in Figure A2 which shows the equipment configuration. Each of the two diversity antenna ports of the base station was connected to its own distributed antenna ("Cable 1" and "Cable 2"). Each of the distributed antennas consisted of two remote antennas arranged in simulcast. The remote antennas for each of the two parallel paths were collocated in two pairs, one pair near the headend ("Cell Location 1") and one pair farther away ("Cell Location 2"), such that there was an overlap zone approximately midway between the two Cell Locations.

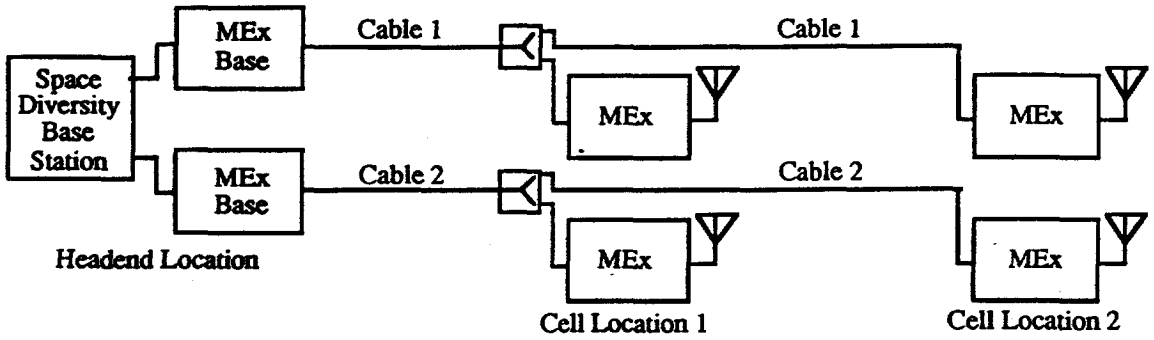

Figure A2. -- Space diversity test setup.

The cable on each distributed antenna system consisted of 0.750-inch aluminum-jacket solid-dielectric coaxial cable, loaned for the test by Cablevision Systems. The remote antenna equipment was suspended from the coaxial cable strand wire, about 18 feet above ground. D.c. power for the MExs was supplied over the coaxial cable from the MEx base.

There is no frequency translation in the MEx equipment: the radio signals to and from the base station are simply amplified. The gains of the MExs were set such that approximately equal levels were received at each base station antenna port from each MEx antenna port, and approximately equal transmitted power levels were delivered from the base station to the MEx antenna ports.

The space-diversity base station at the headend was a Northern Telecom CT2 Companion Deployment Tool, loaned by Rogers Engineering and modified by them so that each of two space diversity inputs/outputs would drive a distributed antenna system.

As shown in Figure A2, the equipment on each distributed antenna system consisted of a microcell extender base unit (MEx base) at the headend, and two microcell extenders (MExs) at the two Cell Locations. This equipment was manufactured by Enterprise Technologies (formerly Nexus). Equipment was loaned by Cablevision Systems, and by Rogers Engineering by arrangement with Enterprise Technologies; CableLabs also used its own MExs and MEx base.

Procedure. -- The intention of the program was to make measurements in the following system configurations:

(a) Each MEx at each Cell Location working individually.

(b) Two MExs simulcasting from Cell Locations 1 and 2 on Cable 1 only.

(c) Two MExs simulcasting from the two cell locations on Cable 2 only.

(d) Two MExs in space diversity on Cables 1 and 2 at Cell Location 1.

(e) Two MExs in space diversity on Cables 1 and 2 at Cell Location 2.

(f) Two MExs simulcasting at Cell Locations 1 and 2 on Cable 1, in space diversity

with two MExs simulcasting from the same Cell Locations on Cable 2.

Results. -- Operation in all the planned configurations was achieved, including what may have been the first space diversity operation over a distributed antenna system in North America (configurations d, e and f).

During space diversity operation with either Cell Location, an improvement in coverage quality was observed. The improvement was in terms of filling in many of the small holes in coverage that show up as pops and clicks, thus increasing the subjective quality rating compared with the non-diversity configurations.

Limited observations in the overlap zone of configuration (f) indicated that space diversity did not appear to degrade performance over the non-diversity case, and may have improved performance.

Next Steps. -- Further more detailed measurements are planned in all these configurations, focusing on measuring:

1. Radio signal levels.
2. Errors in TDD frames.
3. Subjective signal quality.