

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMMScope TECHNOLOGIES LLC

Petitioner

v.

DALI WIRELESS INC.

Patent Owner

IPR2023-_____
U.S. Patent No. 9,197,358

DECLARATION OF SYLVIA HALL-ELLIS, PH.D.

1. I, Sylvia D. Hall-Ellis, Ph.D., declare as follows:

I. INTRODUCTION

2. My name is Sylvia D. Hall-Ellis. I have been retained as an expert by CommScope Technologies, LLC who I am informed is a petitioner to this IPR proceeding (“the Petitioner”).

3. I have written this declaration at the request of the Petitioner to provide my expert opinion regarding the public availability and authenticity of a number of publications identified in Section V below. My Declaration sets forth my opinions in detail and provides the basis for my opinions regarding the authenticity and public availability of these publications. If called to testify in the above-captioned matter, I will testify with regard to the opinions and bases set forth below.

4. I reserve the right to supplement or amend my opinions, and bases for them, in response to any additional evidence, testimony, discovery, argument, and/or other additional information that may be provided to me after the date of this Declaration.

5. I am being compensated for my time spent working on this matter at my normal consulting rate of \$325 per hour, plus reimbursement for any additional reasonable expenses. My compensation is not in any way tied to the content of this report, the substance of my opinions, or the outcome of this proceeding. I have no other interests in this proceeding or with any of the parties.

6. All of the materials that I considered and relied upon are discussed explicitly in this declaration.

II. QUALIFICATIONS

7. I am currently an Adjunct Professor in the School of Information at San José State University in San José, California. I obtained a Master of Library Science from the University of North Texas in 1972 and a Ph.D. in Library Science from the University of Pittsburgh in 1985. Over the last fifty years, I have held various positions in the field of library and information resources. I was first employed as a librarian in 1966 and have been involved in the field of library sciences since, holding numerous positions.

8. I am a member of the American Library Association (ALA) and its Association for Library Collections & Technical Services (ALCTS) Division, and I served on the Committee on Cataloging: Resource and Description (which wrote the new cataloging rules) and as the chair of the Committee for Education and Training of Catalogers and the Competencies and Education for a Career in Cataloging Interest Group. I also served as the Chair of the ALCTS Division's Task Force on Competencies and Education for a Career in Cataloging. Additionally, I have served as the Chair for the ALA Office of Diversity's Committee on Diversity, as a member of the REFORMA National Board of Directors, as a member of the Editorial Board for the ALCTS premier cataloging journal, *Library Resources and Technical*

Services, and as a Co-Chair for the Library Research Round Table of the American Library Association.

9. I have also given over one hundred presentations in the field, including several on library cataloging systems and Machine-Readable Cataloging (“MARC”) standards. My current research interests include library cataloging systems, metadata, and organization of electronic resources.

10. My full curriculum vitae is attached hereto as **Attachment A**.

III. PRELIMINARIES

A. Scope of Declaration and Legal Standards

11. I am not an attorney and will not offer opinions on the law. I am, however, rendering my expert opinion on the authenticity of the documents referenced herein and on when and how each of these documents was disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, could have located the documents before the dates discussed below with respect to the specific documents.

12. I am informed by counsel that a printed publication qualifies as publicly accessible as of the date it was disseminated or otherwise made available such that a person interested in and ordinarily skilled in the relevant subject matter could locate it through the exercise of ordinary diligence.

13. While I understand that the determination of public accessibility under the foregoing standard rests on a case-by-case analysis of the facts particular to an individual publication, I also understand that a printed publication is rendered “publicly accessible” if it is cataloged and indexed by a library such that a person interested in the relevant subject matter could locate it (*i.e.*, I understand that cataloging and indexing by a library is sufficient, though there are other ways that a printed publication may qualify as publicly accessible). One manner of sufficient indexing is indexing according to subject matter category. I understand that the cataloging and indexing by a single library of a single instance of a particular printed publication is sufficient, even if the single library is in a foreign country. I understand that, even if access to a library is restricted, a printed publication that has been cataloged and indexed therein is publicly accessible so long as a presumption is raised that the portion of the public concerned with the relevant subject matter would know of the printed publication. I also understand that the cataloging and indexing of information that would guide a person interested in the relevant subject matter to the printed publication, such as the cataloging and indexing of an abstract for the printed publication, is sufficient to render the printed publication publicly accessible.

14. I understand that routine business practices, such as general library cataloging and indexing practices, can be used to establish an approximate date on

which a printed publication became publicly accessible. I also understand that the indicia on the face of a reference, such as printed dates and stamps, are considered as part of the totality of the evidence.

B. Persons of Ordinary Skill in the Art

15. I am informed by counsel that the subject matter of this proceeding generally relates to wireless communication systems.

16. I have been informed by counsel that a “person of ordinary skill in the art at the time of the invention” is a hypothetical person who is presumed to be familiar with the relevant field and its literature at the time of the invention. This hypothetical person is also a person of ordinary creativity, capable of understanding the scientific principles applicable to the pertinent field.

17. I am informed by counsel that a person of ordinary skill in this subject matter or art would typically be someone who had a bachelor’s degree in electrical engineering and a minimum of 3-4 years of industry experience in wireless communications networks and engineering, including some knowledge of or experience with distributed antenna systems. An individual with a master’s degree in electrical engineering would require less industry experience (e.g., 1-2 years). I have further been informed by counsel that a person of ordinary skill in the art would have been familiar with and able to understand the information known in the art relating to these fields, including the publications discussed in this declaration.

C. Use of Authoritative Databases

18. In preparing this report, I used authoritative databases, such as the OCLC bibliographic database and the Library of Congress Online Catalog, to confirm citation details of the publication discussed. Unless I note otherwise below in reference to a specific serial publication, it is my expert opinion that this standard protocol was followed for the publications discussed in Section V below.

19. *Indexing.* A researcher may discover material relevant to his or her topic in a variety of ways. One common means of discovery is to search for relevant information in an index of periodical and other publications. Having found relevant material, the researcher will then normally obtain it online, look for it in libraries, or purchase it from the publisher, a bookstore, a document delivery service, or other provider. Sometimes, the date of a document's public accessibility will involve both indexing and library date information.

20. Indexing services use a wide variety of controlled vocabularies to provide subject access and other means of discovering the content of documents. The formats in which these access terms are presented vary from service to service.

21. Online indexing services and digital repositories commonly provide bibliographic information, abstracts, and full-text copies of the indexed publications, along with a list of the documents cited in the indexed publication. These services also often provide lists of publications that cite a given document. A citation of a

document is evidence that the document was publicly available and in use by researchers no later than the publication date of the citing document.

22. *ACM Digital Library*.¹ This index is produced by the Association for Computing Machinery, the world's largest scientific and educational computing society. The *ACM Digital Library* contains the full text of all AMC publications, hosted full-text publications from selected publishers, and the ACM Guide to Computing Literature—a comprehensive bibliography of computing literature beginning in the 1950s with more than a million entries. All metadata in the database are freely available on the Web, including abstracts, linked references, citing work, and usage statistics. Full-text articles are available with subscription.

23. *IEEE Xplore*.² This scholarly research database includes indexes, abstracts, and full-text for articles and papers on computer science, electrical engineering, and electronics. The database mainly covers material from the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology. The *IEEE Xplore* digital library provides Web access to more than 4.3-million full-text documents from some of the world's most highly cited publications. The content comprises over 180 journals, over 1,400 conference proceedings, more than 3,800 technical standards, over 1,800 eBooks and over 400

¹ <https://dl.acm.org/>

² <https://ieeexplore.ieee.org/Xplore/home.jsp>

educational courses. Approximately 20,000 new documents are added to *IEEE Xplore* each month. Abstracts are free to access, but access to full text requires a subscription or institutional login.

24. *ResearchGate*.³ *ResearchGate* is a social networking site for scientists and researchers to share papers, ask and answer questions, and find collaborators. According to a 2014 study by Nature and a 2016 article in Times Higher Education, it is the largest academic social network in terms of active users, although other services have more registered users, and a 2015–2016 survey suggests that almost as many academics have Google Scholar profiles. Features available to *ResearchGate* members include following a research interest and the work of other individual participants, a blogging feature for users to write short reviews on peer-reviewed articles, private chat rooms for sharing data, editing documents, or discussing confidential topics, and a research-focused job board. *ResearchGate* indexes self-published information on user profiles and suggests members to connect with others who have similar interests. Member questions are fielded to others who have identified relevant expertise on their profiles.

25. As of 2018, *ResearchGate* had more than 15 million users, with its largest user-bases coming from Europe and North America. Most of *ResearchGate*'s users are involved in medicine, biology, engineering, computer science, agricultural

³ www.researchgate.net

sciences, and psychology. *ResearchGate* publishes a citation impact measurement in the form of an “RG Score,” which is reported to be correlated with existing citation impact measures. *ResearchGate* does not charge fees for putting content on the site and does not require peer review.

26. *Semantic Scholar*.⁴ *Semantic Scholar* is a project developed at the Allen Institute for Artificial Intelligence. Publicly released in November 2015, *Semantic Scholar* is designed to be an AI-backed search engine for scientific journal articles which uses a combination of machine learning, natural language processing, and machine vision to add a layer of semantic analysis to the traditional methods of citation analysis, and to extract relevant figures, entities, and venues from papers. *Semantic Scholar* is designed to highlight important, influential papers, and to identify the connections between them.

27. As of January 2018, following a 2017 project that added biomedical papers and topic summaries, the *Semantic Scholar* corpus included more than 40 million papers from computer science and biomedicine. As of August 2019, the number of included papers had grown to more than 173 million after the addition of the Microsoft Academic Graph records, already used by Lens.org.

D. Summary of Opinions

28. I am informed by counsel that the alleged priority date for the patent at

⁴ www.semanticscholar.org

issue is May 18, 2012. As I will explain below, it is my opinion that the publications discussed in my Declaration were publicly accessible before the alleged May 18, 2012, priority date.

IV. LIBRARY CATALOGING PRACTICES

A. MARC Records

29. I am fully familiar with the library cataloging standard known as the MARC standard, which is an industry-wide standard method of storing and organizing library catalog information. MARC was first developed in the 1960s by the Library of Congress. A MARC-compatible library is one that has a catalog consisting of individual MARC records for works made available at that library.

30. Since at least the early 1970s and continuing to the present day, MARC has been the primary communications protocol for the transfer and storage of bibliographic metadata in libraries.⁵ As explained by the Library of Congress:

31. You could devise your own method of organizing the bibliographic information, but you would be isolating your library, limiting its options, and creating much more work for yourself. Using the MARC standard prevents duplication of work and allows libraries to better share bibliographic resources.

⁵ A complete history of the development of MARC can be found in *MARC: Its History and Implications* by Henrietta D. Avram (Washington, DC: Library of Congress, 1975) and available online from the Hathi Trust (<https://babel.hathitrust.org/cgi/pt?id=mdp.39015034388556;view=1up;seq=1>; last visited November 29, 2022).

Choosing to use MARC enables libraries to acquire cataloging data that is predictable and reliable. If a library were to develop a “home-grown” system that did not use MARC records, it would not be taking advantage of an industry-wide standard whose primary purpose is to foster communication of information.

32. Using the MARC standard also enables libraries to make use of commercially available library automation systems to manage library operations. Many systems are available for libraries of all sizes and are designed to work with the MARC format. Systems are maintained and improved by the vendor so that libraries can benefit from the latest advances in computer technology. The MARC standard also allows libraries to replace one system with another with the assurance that their data will still be compatible.

33. *Why Is a MARC Record Necessary?* LIBRARY OF CONGRESS, <http://www.loc.gov/marc/umb/um01to06.html#part2> (last visited November 29, 2022).

34. Thus, almost every major library in the world is MARC-compatible. *See, e.g., MARC Frequently Asked Questions (FAQ)*, LIBRARY OF CONGRESS, <https://www.loc.gov/marc/faq.html> (last visited November 29, 2022) (“MARC is the acronym for MACHine-Readable Cataloging. It defines a data format that emerged from a Library of Congress-led initiative that began nearly fifty years ago. It provides the mechanism by which computers exchange, use, and interpret

bibliographic information, and its data elements make up the foundation of most library catalogs used today.”). MARC is the ANSI/NISO Z39.2-1994 standard (reaffirmed in 2016) for Information Interchange Format. The full text of the standard is available from the Library of Congress at <http://www.loc.gov/marc/bibliographic/> (last visited November 29, 2022).

35. A MARC record comprises several fields, each of which contains specific data about the work. Each field is identified by a standardized, unique, three-digit code corresponding to the type of data that follow. *See, e.g.,* <http://www.loc.gov/marc/umb/um07to10.html> (last visited November 29, 2022); <http://www.loc.gov/marc/bibliographic/> (last visited November 29, 2022). For example, a work’s title is recorded in field 245, the primary author of the work is recorded in field 100, a work’s International Standard Book Number (“ISBN”) is recorded in field 020, a work’s International Standard Serial Number (“ISSN”) is recorded in field 022, and the publication date is recorded in field 260 under the subfield “c.” *Id.*⁶ If a work is a periodical, then its publication frequency is recorded in field 310, and the publication dates (e.g., the first and last publication) are

⁶ In some MARC records, field 264 is used rather than field 260 to record publication information. *See* <http://www.loc.gov/marc/bibliographic/bd264.html> (last visited November 29, 2022) (“Information in field 264 is similar to information in field 260 (Publication, Distribution, etc. (Imprint)). Field 264 is useful for cases where the content standard or institutional policies make a distinction between functions”).

recorded in field 362, which is also referred to as the enumeration/chronology field. See <http://www.loc.gov/marc/bibliographic/bd3xx.html> (last visited November 29, 2022).⁷

36. The library that initially created the MARC record is reflected in field 040 in subfield “a” with that library’s unique library code. See, e.g., <http://www.loc.gov/marc/umb/um07to10.html> (last visited November 29, 2022); <http://www.loc.gov/marc/bibliographic/> (last visited November 29, 2022). Once a MARC record for a particular work is originally created by one library, other libraries can use that original MARC record to then create their own MARC records for their own copies of the same work. These other libraries may modify or add to the original MARC record as necessary to reflect data specific to their own copies of the work. However, the library that created the original MARC record would still be reflected in these modified MARC records (corresponding to other copies of the same work at other libraries) in field 040, subfield “a”. The modifying library (or

⁷ Upwards of two-thirds to three-quarters of book sales to libraries come from a jobber or wholesaler for online and print resources. These resellers make it their business to provide books to their customers as fast as possible, often providing turnaround times of only a single day after publication. Libraries purchase a significant portion of the balance of their books directly from publishers themselves, which provide delivery on a similarly expedited schedule. In general, libraries make these purchases throughout the year as the books are published and shelve the books as soon thereafter as possible to make the books available to their patrons. Thus, books are generally available at libraries across the country within just a few days of publication.

libraries) is reflected in field 040, subfield “d”. See <http://www.loc.gov/marc/bibliographic/bd040.html> (last visited November 29, 2022).

37. I consulted the Directory of OCLC Libraries (<http://www.oclc.org/contacts/libraries.en.html>; last visited November 29, 2022) in order to identify the institution that created or modified the MARC record. Moreover, when viewing the MARC record online via Online Computer Library Center’s (“OCLC”) bibliographic database, which I discuss further below, hovering over a library code in field 040 with the mouse reveals the full name of the library. I also used this method of “mousing over” the library codes in the OCLC database to identify the originating and modifying libraries for the MARC records discussed in this Declaration.

38. MARC records also include one or more fields that show information regarding subject matter classification. For example, 6XX fields are termed “Subject Access Fields.” See <http://www.loc.gov/marc/bibliographic/bd6xx.html> (last visited November 29, 2022). Among these, for example, is the 650 field; this is the “Subject Added Entry – Topical Term” field. See <http://www.loc.gov/marc/bibliographic/bd650.html> (last visited November 29, 2022). The 650 field is a “[s]ubject added entry in which the entry element is a topical term.” *Id.* These entries “are assigned to a bibliographic record to provide

access according to generally accepted thesaurus-building rules (e.g., *Library of Congress Subject Headings* (LCSH), *Medical Subject Headings* (MeSH)).” *Id.*

39. Further, MARC records can include call numbers, which themselves contain a classification number. For example, a MARC record may identify a 050 field, which is the “Library of Congress Call Number.” See <http://www.loc.gov/marc/bibliographic/bd050.html> (last visited November 29, 2022). A defined portion of the Library of Congress Call Number is the classification number, and “source of the classification number is *Library of Congress Classification* and the *LC Classification-Additions and Changes*.” *Id.* Thus, the 050 field may be used to show information regarding subject matter classification. As another example, a MARC record may identify a 082 field, which is the “Dewey Decimal Classification Number.” See <http://www.loc.gov/marc/bibliographic/bd082.html> (last visited November 29, 2022). A defined portion of the Dewey Decimal Classification Number is the classification number, and “source of the classification number is the Dewey Decimal Classification and Relative Index,” which is published online. *Id.* Thus, the 082 field may be used to show information regarding subject matter classification consistent with the Dewey Decimal Classification System.

40. Each item in a library has a single classification number. A library selects a classification scheme (e.g., the Library of Congress Classification scheme

just described or a similar scheme such as the Dewey Decimal Classification scheme) and uses it consistently. When the Library of Congress assigns the classification number, it appears as part of the 050 field, as discussed above. For MARC records created by libraries other than the Library of Congress (e.g., a university library or a local public library), the classification number may appear in a 09X (e.g., 090) field. See <http://www.loc.gov/marc/bibliographic/bd09x.html> (last visited November 29, 2022).

41. When a MARC-compatible library acquires a work, it creates a MARC record for its copy of the work in its computer catalog system in the ordinary course of its business. This MARC record (for the copy of a work available at the particular library) may be later accessed by researchers in a number of ways. For example, many libraries, including the Library of Congress, make their MARC records available through their website. As an example, the MARC record for the copy of *The Unlikely Spy*, by Daniel Silva,⁸ available at the Library of Congress can be viewed through the Library of Congress website, at <https://catalog.loc.gov/vwebv/staffView?searchId=20265&recPointer=1&recCount=25&bibId=2579985> (last visited November 29, 2022). One could, of course, always physically visit the library at which the work is available, and request to see

⁸ *The Unlikely Spy* is a 1996 novel written by Daniel Silva, who happens to be one of my favorite authors.

that library's MARC record for the work. Moreover, members of the Online Computer Library Center ("OCLC") can access the MARC records of other member institutions through OCLC's online bibliographic database, as I explain further below.

B. OCLC

42. The OCLC was created "to establish, maintain and operate a computerized library network and to promote the evolution of library use, of libraries themselves, and of librarianship, and to provide processes and products for the benefit of library users and libraries, including such objectives as increasing availability of library resources to individual library patrons and reducing the rate of rise of library per-unit costs, all for the fundamental public purpose of furthering ease of access to and use of the ever-expanding body of worldwide scientific, literary and educational knowledge and information."⁹ Among other services, OCLC and its members are responsible for maintaining the WorldCat database (<http://www.worldcat.org/>; last visited November 29, 2022), used by independent and institutional libraries throughout the world. All libraries that are members of OCLC are MARC-compatible. See, e.g.,

⁹ Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Incorporated (available at <https://www.oclc.org/content/dam/oclc/membership/articles-of-incorporation.pdf>; last visited November 29, 2022).

https://help.oclc.org/Metadata_Services/OCLC-MARC_records/About_OCLC-MARC_records (last visited November 29, 2022) (“OCLC-MARC records describes records produced since November 1993.”). Parallel to the two superseded OCLC documents, this revised set of guidelines is intended to assist catalogers in creating records for electronic resources in WorldCat, the OCLC Online Union Catalog. These guidelines pertain to OCLC-MARC tagging (that is, content designation). Cataloging rules and manuals govern the content of records and should be implemented immediately at the local library.

43. When an OCLC member institution acquires a publication, like the other MARC-compatible libraries discussed above, it creates a MARC record for this publication in its computer catalog system in the ordinary course of its business. MARC records created at the Library of Congress were tape-loaded into the OCLC database through a subscription to MARC Distribution Services daily or weekly. Once the MARC record is created by a cataloger at an OCLC member library and contributed by the Library of Congress, the MARC record is then made available to any other OCLC members online, and thereby made available to the public. Accordingly, once the MARC record is created by a cataloger at an OCLC member library and contributed to the OCLC bibliographic database, any publication corresponding to the MARC record has been cataloged and indexed according to its subject matter such that a person interested in that subject matter could, with

reasonable diligence, locate and access the publication through any library with access to the OCLC bibliographic database or through the Library of Congress.

44. When a MARC-compatible library creates an original MARC record for a work, the library records the date of creation of that MARC record in **field 008**, characters 00 through 05, in the ordinary course of its business. See <http://www.loc.gov/marc/bibliographic/bd008a.html> (last visited November 29, 2022). For OCLC member institutions that use OCLC software to create original MARC records, the date of creation in field 008 is automatically supplied by the OCLC software. The MARC record creation date in field 008 thus reflects the date on which, or shortly after which, a work was first acquired and cataloged by the library that created the original MARC record.

45. When other MARC-compatible libraries subsequently acquire their own copies of the same work, as mentioned, they create MARC records in their own computer catalog systems for their copies in the ordinary course of business.¹⁰ They may use a MARC record previously created for that work (e.g., by another MARC-compatible library) to create their own MARC records for their own copies of that same work.¹¹ The previously created MARC record used by subsequently-acquiring

¹⁰ Initial contributions to the bibliographic database for a work are called “master records.”

¹¹ When a local library uses a master record in OCLC and produces (or downloads) it to the in-house system, the three-character symbol for the subsequent library is added to the holdings for the work.

libraries to create MARC records for their own copies may be obtained through the OCLC bibliographic database, as described above. If, when creating a MARC record to represent its own copy of the work, the subsequently-acquiring library uses the master MARC record in its original form, the subsequently-acquiring library cannot reenter data into the 008 field; therefore, the date in the 008 field will continue to reflect the date the MARC record was initially created by the originating library. On the other hand, if the subsequently-acquiring library modifies the previously created MARC record when creating its own MARC record for its own copy of the work, the subsequently-acquiring library may enter into the 008 field of its own MARC record the date its own MARC record was created.¹² But the library that created the original MARC record used by the subsequently-acquiring library would still be reflected in the MARC record of the subsequently-acquiring library in field 040, subfield “a”. Thus, the work identified by any MARC record possessed by any MARC-compatible library would have been accessible to the public at least as of the date shown in the 008 field, or shortly thereafter, either from the library that possesses the MARC record itself, or from the originating library indicated in field 040, subfield “a”. As discussed, a MARC-compatible library in the ordinary course

¹² This practice is not required by, but is nevertheless consistent with, the MARC standard. Many MARC records exist today whose 008 fields indicate when the first original MARC record for a work was created, rather than when a derivative record was created based on the original MARC record by a subsequently-acquiring library for its own computer catalog system.

of its business creates a MARC record in its own catalog system for a work when it acquires a copy of that work.

46. Moreover, when a MARC record is created by a library for its own copy of a work, **field 005** is automatically populated with the date that MARC record was created in year, month, day format (YYYYMMDD). See <http://www.loc.gov/marc/bibliographic/bd005.html> (last visited November 29, 2022).¹³ Thereafter, the library's computer system may automatically update the date in field 005 every time the library updates the MARC record (*e.g.*, to reflect that an item has been moved to a different shelving location within the library). *Id.*¹⁴ Thus, the work identified by any MARC record possessed by any MARC-compatible library would have been accessible to the public at least as of the date shown in the 005 field, or shortly thereafter, from the library that possesses the MARC record itself. As noted, because the 005 field may be updated each time the library updates its MARC record, the work identified by the MARC record may, in fact, have been accessible to the public from that library much earlier than the date indicated in the 005 field.

¹³ Some of the newer library catalog systems also include hour, minute, second (HHMMSS).

¹⁴ Field 005 is visible when viewing a MARC record via an appropriate computerized interface. But when a MARC record is printed directly to hardcopy from the OCLC database, the "005" label is not shown. The date in the 005 field instead appears next to the label "Replaced."

47. Based on my personal experience as a professional librarian using the MARC and OCLC resources, it has been my experience that both of these resources were continuously operational and available since at least 1992. Indeed, in the course of my work, I have extensively used both of these resources over the past 30+ years, and I have consistently found the information contained within these resources to be complete and reliable. I have never found the date of accessibility as indicated in fields 008 or 005 to be incorrect. And in only a minute number of cases have I found any errors at all in these records – none of which affected my ability to render an accurate opinion as to accessibility, indexing, or subject headings.

V. PUBLICATIONS IN THIS PROCEEDING

A. “Imperfect Digital-Fiber-Optic-Link-Based Cooperative Distributed Antennas with Fractional Frequency Reuse in Multicell Multiuser Networks” by Xinyi Xu, Rong Zhang, Salman Ghafoor, and Lajos Hanzo (“Xu”) [Exhibit 1005]

48. Exhibit 1005 is a copy of an article published in Volume 60, Number 9 of the journal *IEEE Transactions on Vehicular Technology* found in the Library of Congress. The article “Imperfect Digital-Fiber-Optic-Link-Based Cooperative Distributed Antennas with Fractional Frequency Reuse in Multicell Multiuser Networks” by Xinyi Xu, Rong Zhang, Salman Ghafoor, and Lajos Hanzo (hereafter “Xu”) appears beginning on page 4439 of this issue dated November 2011. Exhibit 1005 is a true and correct copy of the Xu article (pages 4439-4449). I obtained this copy of the article from Library of Congress. Specifically, the text of the article is

complete; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Exhibit 1005 was found within the custody of a library – a place where, if authentic, a copy of this journal would likely be. Exhibit 1005 are true and correct copies in a condition that creates no suspicion about their authenticity.

49. The Xu journal article is available from the *IEEE Xplore* database¹⁵ and the digital repositories *ResearchGate*¹⁶ and *Semantic Scholar*.¹⁷

50. Attached hereto as Attachment 1a is a true and correct copy of the MARC record for the journal *IEEE Transactions on Vehicular Technology* from the Library of Congress. The library ownership is indicated by the presence of the library's name at the top of each page. I personally identified and retrieved the MARC record that is Attachment 1a.

51. As noted in the holdings information (field 362), the Library of Congress has received the journal *IEEE Transactions on Vehicular Technology* since October 1967 and continues to receive the publication.¹⁸ In view of the MARC

¹⁵ <https://ieeexplore.ieee.org/document/6036194>

¹⁶ https://www.researchgate.net/publication/254017976_Imperfect_Digital-Fiber-Optic-Link-Based_Cooperative_Distributed_Antennas_With_Fractional_Frequency_Reuse_in_Multicell_Multiuser_Networks

¹⁷ <https://www.semanticscholar.org/paper/Imperfect-Digital-Fiber-Optic-Link-Based-Antennas-Xu-Zhang/0dd8a3b26a0dd0ce113213201e0acaf1e7148aba>

¹⁸ The publication was originally titled *Transactions of the IRE Professional Group on Vehicular Communications* (February 1952-June 1954), changed the title to *IRE*

record for Exhibit 1005, the Xu article was publicly available on November 30, 2011.¹⁹

52. The “BLvl” entry in Attachment 1a is “s,” which indicates that the journal *IEEE Transactions on Vehicular Technology* is a serial publication. Field 310 of Attachment 1a reads “Nine times a year, \$b <Nov. 2012-.” Accordingly, the MARC record for Exhibit 1005 corresponds to those issues of the journal *IEEE Transactions on Vehicular Technology* from the time of the serial adopted the current title to the present day.

53. Attachment 1a further includes an entry in field 050 (“TK7882.M6 \$b .I2”)— includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal classification system) and an entry in field 082 (“621.3841/65”)— includes a subject matter classification number consistent with the Dewey Decimal classification system. Attachment 1a further includes a descriptor term reading “Mobile communication

Transactions on Vehicular Communications (June 1955-August 1962), changed the title again to *IEEE Transactions on Vehicular Communications* (September 1963-October 1966) and adopted the current title, *IEEE Transactions on Vehicular Technology*, in October 1967.

¹⁹ The journal *IEEE Transactions on Vehicular Technology* was published bimonthly and, therefore, new issues were available approximately 60 days. Based on the frequency of publication (see Attachment 1a, second field 321) and my years of experience working with serials, it is my opinion that issues would be published by the end of the month. Therefore, a public availability date of November 30, 2011, is reasonable.

systems \$v Periodicals” (see Attachment 1b, Library of Congress sh2010102188) in the 650 field. Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Attachment 1a was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of September 21, 1975, the MARC record attached hereto as Attachment 1a was accessible through any library with access to the OCLC bibliographic database or the online catalog at a library that subscribed to the serial, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC bibliographic database or through an individual library.

54. Attached hereto as Attachment 1c is a true and correct copy of the MARC record for the journal *IEEE Transactions on Vehicular Technology* obtained from the OCLC bibliographic database. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Attachment 1c, that library code is “MUL,” which means that the MARC record for this serial was cataloged as part of the Minnesota Union List of Serials at the University of Minnesota Libraries (Minneapolis, Minnesota). As can be seen in the “Entered” field in the MARC record for this exhibit, a cataloger at the University of Minnesota Libraries created OCLC record number 1644964 on September 21, 1975, as shown in the “Entered” field (“19750921”). The library continues to update and enhance

the MARC record to meet current cataloging rules. The most recent enhancement to Attachment 1c occurred on November 1, 2022, as shown in the “Replaced” field (“20221101”). I personally identified and retrieved the MARC record that is Attachment 1c.

55. The “BLvl” entry in Attachment 1c is “s,” which indicates that the journal *IEEE Transactions on Vehicular Technology* is a serial publication. Field 310 of Attachment 1c reads “Nine times a year, \$b <Nov. 2012-.” Accordingly, the MARC record for Exhibit 1005 corresponds to the journal *IEEE Transactions on Vehicular Technology* from the time the serial title adopted the current title and includes the date of the Xu article.

56. Attachment 1c includes an entry in field 050 (“TK7882.M6 \$b .I2”)—as described above, a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal classification system) and an entry in field 082 (“621.3841/65”), a subject matter consistent with the Dewey Decimal classification system. Attachment 1c further includes a descriptor term reading “Mobile communication systems \$v Periodicals” (see Attachment 1b, Library of Congress sh2010102188) in the 650 field. Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Attachment 1c was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry,

and the field 650 entry. As of September 21, 1975, the MARC record attached hereto as Attachment 1c was accessible through any library with access to the OCLC bibliographic database or the online catalog at a library that subscribed to the serial, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC bibliographic database or through an individual library.

57. Attachment 1c indicates that the journal *IEEE Transactions on Vehicular Technology* as cataloged at the University of Minnesota Libraries is currently available from 382 libraries. In view of the above, this issue of the journal *IEEE Transactions on Vehicular Technology* was publicly available on November 30, 2011, because by that date it had been cataloged and indexed at the University of Minnesota Libraries, made part of the OCLC bibliographic database, and received at the Library of Congress. For these reasons, it is my opinion that Exhibit 1005 was published and accessible to the public on November 30, 2011.

B. “A Novel Inter-Cell Interference Coordination Scheme for Relay Enhanced Cellular Networks” by Pengfei Ren, Xiaogang Li, Chengkang Pan, Xiaodong Shen, Jianming Zhang, Lin Sang, and Dacheng Yang [Exhibit 1027]

58. Attached hereto as Exhibit 1027 is a copy of a conference paper published in the digital book titled *2011 IEEE Vehicular Technology Conference* found in the King Library at San José State University (San José, California). The conference paper titled “A Novel Inter-Cell Interference Coordination Scheme for

Relay Enhanced Cellular Networks” by Pengfei Ren, Xiaogang Li, Chengkang Pan, Xiaodong Shen, Jianming Zhang, Lin Sang, and Dacheng Yang (hereafter “Ren”) appears beginning on page 1. The conference papers were presented at the VTC Fall 2011 IEEE Vehicular Technology Conference which was held on September 5-8, 2011, in San Francisco, California. Exhibit 1027 is a true and correct copy of the Ren conference paper (pages 1-5). I obtained this copy of the conference paper from the *IEEE Xplore* database²⁰ in the King Library at San José State University. The *IEEE Xplore* database indicates that the Ren article was added on December 1, 2011. Specifically, the text of the Ren conference paper is complete; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Exhibit 1027 was found within the custody of a library – a place where, if authentic, a copy of this conference proceedings volume would likely be. Exhibit 1027 is a true and correct copy in a condition that creates no suspicion about authenticity.

59. Attached hereto as Attachment 2a is a true and correct copy of the MARC record for the digital volume titled *2011 IEEE Vehicular Technology Conference* obtained from the OCLC bibliographic database. I personally identified and retrieved the MARC record that is Attachment 2a. As previously noted, the library that created the record is recorded in field 040 with a unique library code.

²⁰ <https://ieeexplore.ieee.org/document/6092955>

For Attachment 2a, that library code is “COO,” which means that the MARC record for this conference proceedings digital volume was cataloged in the Mann Library at Cornell University (Ithaca, New York). As can be seen in the “Entered” field in the MARC record for this exhibit, a cataloger in the Mann Library at Cornell University created OCLC record number 812660852 on June 25, 2010, as shown in the “Entered” field (“20100625”). The library continues to update this MARC record the MARC record to meet current cataloging rules. The most recent enhancement to the MARC record occurred on June 13, 2022, as shown in the “Replaced” field (“20220613”).

60. Attachment 2a further includes an entry in field 050 (“TA1235”)—as described above, a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal classification system). Attachment 2a also shows that the digital volume was catalogued with five descriptor terms reading “Electronics in transportation \$v Congresses” (see Attachment 2b, Library of Congress subject heading sh2008119337), “Mobile communication systems \$v Congresses” (Attachment 2c, Library of Congress subject heading sh2008107882), “Wireless communication systems \$v Congresses” (see Attachment 2d, Library of Congress subject heading sh2008113541), “Intelligent transportation systems \$v Congresses” (Attachment 2e, Library of Congress subject heading sh2008123956), and “Ubiquitous computing \$v

Congresses” (Attachment 2f, Library of Congress subject heading sh2008113063) in the 650 fields. Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Attachment 2a was indexed according to its subject matter by virtue of at least two independently sufficient classifications: the field 050 entry and the field 650 entries. Further, as of June 25, 2010, the MARC record attached hereto as Attachment 2a was accessible through any library with access to the OCLC bibliographic database or the online catalog at a library that acquired the conference proceedings volume, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC bibliographic database or through an individual library.

61. Attachment 2a indicates that the volume titled *2011 IEEE Vehicular Technology Conference* as cataloged in the Mann Library at Cornell University is currently available from 254 libraries. In view of the above, the print version of the volume titled *2011 IEEE Vehicular Technology Conference* was publicly available on December 1, 2011, because by that date it had been received, cataloged, and indexed in the Mann Library at Cornell University and made part of the OCLC bibliographic database. For these reasons, it is my opinion that Exhibit 1027 was published and publicly accessible on December 1, 2011.

C. *Inter-cell Interference Handling for E-UTRA*, TSG-RAN WG1 #42 (“Ericsson”) [Exhibit 1007]

62. Attached hereto as Exhibit 1007 is a true and accurate copy of report

R1-050764 titled *Inter-cell Interference Handling for E-UTRA* prepared by Ericsson for presentation and discussion at the 3GPP meeting held on August 29-September 2, 2005, in London (hereafter “Ericsson”). I identified and downloaded Exhibit 1007 from the 3GPP working Group 1 website.²¹ Documents for the meeting included the agenda (see Attachment 3a) which included this document as Discussion Item 10.2, “Inter-cell Interference Mitigation/Coordination.” The Ericsson report is included in the “documents” section by scrolling down to its identifying number (R1-050764).²² The 3rd Generation Partnership Project provided the 3GPP document on its website on August 25, 2005. Exhibit 1007 accurately reflects the contents of the above website link on the date of capture and has not been changed or altered in any way—the text of the 3GPP document in Exhibit 1007 is complete; no pages are missing; and, further, there are no visible alterations to the document. I understand that the appearance, contents, substance, and distinctive characteristics of Exhibit 1007 create no suspicion about its authenticity. As such, it is my opinion that Exhibit 1007 is authentic.

63. I understand that prior to May 18, 2012, 3GPP would have been known to persons at least of ordinary skill in the art as an organization that brought together different telecommunications organizations to develop and produce technical

²¹ https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_42

²² https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_42/Docs

specifications related to Global System for Mobile Communications (GSM). Furthermore, I understand that persons of ordinary skill in the art would have reasonably considered this organization and its website – <http://www.3gpp.org> – as reliable and useful sources of information for research, study, development, or design of systems using SMS and two-way messaging technologies. It is my opinion that the 3GPP document is a reliable authority for research, study, development, or design of protocols for systems using SMS and two-way messaging technologies.

64. Given that the 3GPP.org website was accessible to the public prior to May 18, 2012, I understand that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence could have located the 3GPP document from the 3GPP website using the common search terms discussed above and/or reasonable diligence. Indeed, upon accessing the 3GPP website, such an interested researcher would have found the 3GPP document by simply clicking on the “TSG-RAN Working Group 1” link followed by the meeting date link and applying reasonable diligence.

65. For the foregoing reasons, it is my opinion that Exhibit 1007 was publicly accessible to persons interested in and ordinarily skilled in the art exercising reasonable diligence no later than August 25, 2005 (if not sooner).

D. *Further Analysis of Soft Frequency Reuse Scheme*, TSG-RAN WG1 #42 (“Huawei”) [Exhibit 1006]

66. Attached hereto as Exhibit 1006 is a true and accurate copy of report

R1-050841 titled *Further Analysis of Soft Frequency Reuse Scheme* prepared by Huawei for presentation and discussion at the 3GPP meeting held on August 29-September 2, 2005, in London (hereafter “Huawei”). I identified and downloaded Exhibit 1006 from the 3GPP working Group 1 website.²³ Documents for the meeting included the agenda (see Attachment 4a) which included this document as Discussion Item 10.2, “Inter-cell Interference Mitigation/Coordination.” The Huawei report is included in the “documents” section by scrolling down to its identifying number (R1-050841).²⁴ The 3rd Generation Partnership Project provided the 3GPP document on its website on August 25, 2005. Exhibit 1006 accurately reflects the contents of the above website link on the date of capture and has not been changed or altered in any way—the text of the 3GPP document in Exhibit 1006 is complete; no pages are missing; and, further, there are no visible alterations to the document. I understand that the appearance, contents, substance, and distinctive characteristics of Exhibit 1006 create no suspicion about its authenticity. As such, it is my opinion that Exhibit 1006 is authentic.

67. I understand that prior to May 18, 2012, 3GPP would have been known to persons at least of ordinary skill in the art as an organization that brought together different telecommunications organizations to develop and produce technical

²³ https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_42

²⁴ https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_42/Docs

specifications related to Global System for Mobile Communications (GSM). Furthermore, I understand that persons of ordinary skill in the art would have reasonably considered this organization and its website – <http://www.3gpp.org> – as reliable and useful sources of information for research, study, development, or design of systems using SMS and two-way messaging technologies. It is my opinion that the 3GPP document is a reliable authority for research, study, development, or design of protocols for systems using SMS and two-way messaging technologies.

68. Given that the 3GPP.org website was accessible to the public prior to May 18, 2012, I understand that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence could have located the 3GPP document from the 3GPP website using the common search terms discussed above and/or reasonable diligence. Indeed, upon accessing the 3GPP website, such an interested researcher would have found the 3GPP document by simply clicking on the “TSG-RAN Working Group 1” link followed by the meeting date link and applying reasonable diligence.

69. For the foregoing reasons, it is my opinion that Exhibit 1006 was publicly accessible to persons interested in and ordinarily skilled in the art exercising reasonable diligence no later than August 25, 2005 (if not sooner).

VI. CONCLUSION

70. In signing this Declaration, I recognize that the Declaration will be filed

as evidence in a case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

71. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: January 9, 2023

Respectfully submitted,

By: 
Sylvia D. Hall-Ellis, Ph.D.

EXHIBIT 1005

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Imperfect Digital-Fiber-Optic-Link-Based Cooperative Distributed Antennas With Fractional Frequency Reuse in Multicell Multiuser Networks

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Abstract—The achievable throughput of the entire cellular area is investigated, when employing fractional frequency reuse techniques in conjunction with realistically modeled imperfect optical-fiber-aided distributed antenna systems (DASs) operating in a multicell multiuser scenario. Given fixed total transmit power, substantial improvement of the cell-edge area's throughput can be achieved without reducing the cell center's throughput. The cell edge's throughput supported in the worst-case direction is significantly enhanced by the cooperative linear transmit processing technique advocated. Explicitly, a cell-edge throughput of $\eta = 5$ bit/s/Hz may be maintained for an imperfect optical fiber model, regardless of the specific geographic distribution of the users.

Index Terms—COMP, distributed antennas, fractional frequency reuse, multi-cell networks, multi-user networks, ROF.

I. INTRODUCTION

THE CLASSIC unity frequency reuse (UFR) pattern may be applied by wireless systems to maximize the attainable area spectral efficiency at the cost of increasing the co-channel interference (CCI) level; hence, the UFR typically exhibits low throughput at the cell edge. As a remedy, the fractional frequency reuse (FFR) [1] philosophy may be invoked, which reduced the CCI at the cell edge at the cost of reduced area spectral efficiency. Hence, the FFR scheme is capable of improving the cell-edge signal-to-interference-plus-noise ratio (SINR) [2]. As a result, FFR has also been adopted in the Third Generation Partnership Project's (3GPP) long-term evolution

(LTE) initiative [3] and in the Worldwide interoperability for Microwave Access (WiMAX) [4] system.

By contrast, a DAS improves the cell-edge throughput by placing the remote antennas (RAs) closer to the cell-edge terminals, hence naturally reducing the pathloss [5]. However, the reduced pathloss will increase the interference imposed on the cell-edge terminals served by the neighboring RAs. In practice, only the mobile stations (MSs) can be granted a high throughput, which roam in the vicinity of the RA. When the MS is roaming near the angle halfway between two adjacent RAs [6], [7], its throughput is reduced; hence, we will refer to this as the "worst-case direction" problem. As a potential remedy, cooperative processing techniques, which have been considered for base stations (BSs) [2], [8], may be adopted for the DAS scenario considered to mitigate the inter-RA interference (IRI), particularly in the worst-case direction. The family of BS cooperation techniques is capable of efficiently mitigating the CCI; hence, it was also considered as a candidate for next-generation wireless networks by the 3GPP organization [9]. However, the family of BS cooperation techniques still relies on the classic architecture of a single centralized BS covering the entire cell, where the pathloss- and shadow-fading-induced problem of the cell-edge users may not be readily solved. Hence, to achieve a high throughput for the entire cellular area, particularly for the cell-edge terminals, we propose to combine DASs with cooperative BS processing techniques.

For practical application of DASs, the connection between the BS and RAs may be a coaxial cable, optical fiber, or a radio-frequency (RF) link [10], [11]. The radio over fiber (RoF) [12] and digital fiber optic (DFO)-link-based [13] transmission technique may also be used for the BS to RA links, which is more reliable than a wireless backhaul, albeit also being more costly. In contrast to the RoF family [14], the DFO link is immune to the sideband cancellation phenomenon, which occurs in the RoF system [15], [16], and it is capable of avoiding both the intermodulation distortions of the optical fiber and the nonlinearity imposed by the optical components, but this is typically achieved at an increased complexity and cost [13]. Additionally, optical multilevel signaling transmission techniques [17], [18] may be applied for the DFO link, which are capable of reducing the complexity of the optical receiver at the RA. Hence, in this study, we opted for the DFO link. As a further benefit, DFO techniques also allow us to preprocess the downlink (DL) transmit signal for all the users in the central BS, before it is transmitted to the MS. Hence, the DFO backhaul may also

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support the extension of BS cooperation techniques [19] to the DASs. Furthermore, when aiming to support gigabit transmissions, which is the goal of LTE-Advanced (LTE Release 10) [20], these high-rate systems may suffer from the effects of both the dispersion and nonlinearity imposed by the optical fiber links of the DASs [21]. Hence, jointly considering the effects of the DFO link and wireless links becomes important when analyzing the performance of DAS systems designed for LTE-Advanced applications.

Against this background, in this paper, we quantify the attainable throughput across the entire cellular coverage area in a multicell multiuser scenario, when employing cooperative techniques beneficially combined with both realistically modeled imperfect optical-fiber-aided DASs and FFR. More explicitly, we introduced the split-step Fourier (SSF) method [22] to analyze how the dispersion and nonlinearity of the optical fiber link affect the throughput of the cell-edge area.

- 1) Although the dispersion of the optical signaling pulse may be viewed as an undesirable imperfection of a pure optical fiber system, ironically, it might result in beneficial throughput enhancements in the cell-edge area of the noncooperative RA-aided FFR system. This is because the dispersion-induced attenuation of the optical signaling pulses may be capable of mitigating the IRI in the multicell multiuser scenario. However, we will demonstrate that, due to the worst-case direction problem caused by the IRI, the noncooperative RA-aided FFR system may not always lead to an improved attainable throughput in the entire cell-edge area.
- 2) We will also demonstrate that employing a single omnidirectional transmit antenna at each RA and a single receive antenna at each MS but jointly designing the transmit preprocessing (TPP) matrix of all the cooperative RAs combined with FFR is capable of achieving an increased throughput for the entire cell-edge area, regardless of the specific geographic distribution of the users. Furthermore, even though conventional cooperative signal-processing techniques are unable to directly mitigate the optical fiber receiver's self-inflicted noise, the proposed cooperative RA-aided FFR system exhibits a higher attainable throughput than conventional noncooperative FFR-aided systems, particularly in the worst-case direction.

Our results that were not included here for reasons of space economy suggest that the IRI experienced in the local cell dominates the interference experienced in the DFO-link-aided DAS combined with FFR. We also found that the DAS combined with FFR requires reduced transmit power at each RA, which naturally limits the IRI imposed by the cells using the same frequency band in a tier-two cell. Hence, the IRI inflicted by the tier-two cells will be neglected to simplify our analysis in the multicell multiuser scenario considered.

Our paper is organized as follows: In Section II, we introduce the multicell multiuser topology considered and describe the imperfect optical fiber model. In Section III, we outline the received signal model of the noncooperative DAS with the FFR system (Section III-A), introduce several cooper-

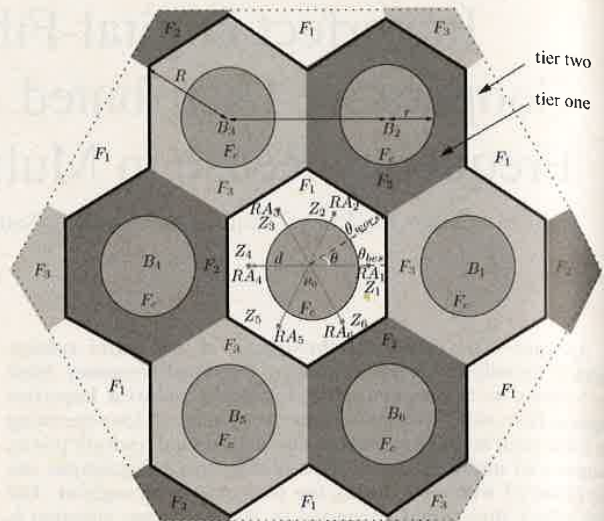


Fig. 1. Topology of two tiers of 19 cells relying on an FFR and DAS arrangement, where $N_r = 6$ RAs are employed. The structure of the cells in tier two is the same as that in tier one.

ative linear processing techniques (Section III-B), and present our link-level results recorded for a range of practical modulation and coding schemes (MCSs, Section III-C), followed by our performance evaluations in Section IV. Finally, we conclude our discourse in Section V.

II. SYSTEM DESCRIPTION AND OPTICAL FIBER MODELING

A. Multicell Multiuser System Topology

The multicell multiuser scenario based on the FFR scheme is shown in Fig. 1, which consists of two tiers of 19 hexagonal cells [23] surrounding the central BS B_0 , where B_0 is assumed to be at the origin. We assume symmetry, where every cell has the same system configuration and focus our attention on cell B_0 of Fig. 1 without any loss of generality. The frequency-partitioning strategy of the total available bandwidth F is characterized by $F_c \cap F_e = \emptyset$, where F_c and F_e represent the cell center's frequency band and the cell edge's frequency band, respectively. F_e is divided into three orthogonal frequency bands F_i , $i \in [1, 3]$, which were exclusively used at the cell edge of one of the three adjacent cells.

To simplify the structure, we assume that the number of active MSs N_m and RAs N_r is the same ($N_m = N_r$), which implies that each RA may support a single MS. The users are assumed to be randomly distributed in the cell-edge area, and a total of N_m MSs are roaming at any point Z_i , as described by the polar coordinates of $[\theta_{Zi}, L_{Zi}]$, $i \in [1, N_m]$. A total of N_r RAs are employed in each cell described by its polar coordinates denoted by $[\theta_{Ri}, L_{Ri}] = [2\pi(i-1)/N_r, d]$, $i \in [1, N_r]$. Likewise, the BSs in tier one are described by their polar coordinates of $[\theta_{Bj}, L_{Bj}] = [2\pi(j-1)/6, \sqrt{3}R]$, $j \in [1, 6]$, and the polar coordinates of the BSs in tier two may also be readily obtained from the underlying simple geometry. Fig. 2 shows a single optical fiber link spanning from the BS to the RA.

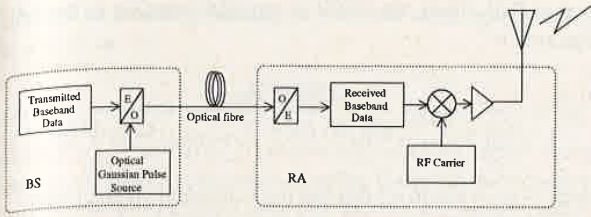


Fig. 2. System architecture of the DFO link, showing a single optical fiber link spanning from the BS to the RA. The transmitted baseband data are used to modulate a stream of optical Gaussian pulses, where an ideal optical modulator is assumed; therefore, it does not impose any chirp on the optical pulse. Then, the Gaussian optical signaling pulses are transmitted through the optical fiber, which imposes both linear and nonlinear distortions. At the RA, after an ideal photodetector, the optical signaling pulses are converted back to the corresponding baseband electronic signals.

B. Imperfect Optical Fiber Model

To investigate the system topology previously introduced, we assume that the links from BS B_0 of Fig. 1 to the RAs are constituted by a realistic imperfect optical fiber, rather than simply assuming a perfect optical fiber. The phase rotation imposed by the optical fiber link on the modulated signal constellation diagram is supposed to be compensated; hence, in this paper, we only considered the fiber-induced imperfections imposed on the modulated signal's amplitude. Hence, the signal received at RA i after passing through the realistically modeled optical fiber may be written as follows:

$$s_i = A_L x_i + n_f \quad (1)$$

where A_L , x_i , and $n_f \sim \mathcal{CN}(0, \sigma_f^2)$ represent the received amplitude of the optical pulse after passing through the optical fiber having a total length of L , the transmitted signal, and the complex-valued additive white Gaussian noise (AWGN), respectively. Furthermore, the so-called *pulse-broadening* (PB) effect caused by dispersion [24] may not impose a significant performance limitation in pure optical fiber links since the interpulse-interference may be negligible for the transmission of the baseband signal through the DFO link. However, the PB additionally imposes an attenuation of the optical signaling pulse, which may affect the attainable throughput of the cell-edge area, when considering our DFO-link-aided DAS combined with FFR in a multicell multiuser scenario.

To elaborate on our optical fiber model a little further, parameter A_L takes into account the fiber's attenuation, its dispersion, and the fiber's nonlinearity characterized by the generalized nonlinear Schrödinger (NLS) equation [22] expressed in the form of

$$\frac{\partial A}{\partial z} = \underbrace{\left(\frac{\beta_3}{6} \frac{\partial^3}{\partial t^3} - \frac{i\beta_2}{2} \frac{\partial^2}{\partial t^2} - \frac{\alpha}{2} \right)}_{\hat{D}} A + \underbrace{i\xi \left(|A|^2 + \frac{i}{\omega_0} \frac{1}{A} \frac{\partial}{\partial t} (|A|^2 A) - T_R \frac{\partial |A|^2}{\partial t} \right)}_{\hat{N}} A \quad (2)$$

where $A(z, t)$ is the Gaussian signaling pulse envelope as a function of both time t and propagation distance z . The term $\hat{D}$

characterizes the dispersion and fiber loss effects, whereas $\hat{N}$ characterizes the nonlinearity effects, as the pulse propagates along the optical fiber. Still considering (2), in the term $\hat{D}$, α represents the fiber attenuation, β_2 is the group-velocity dispersion (GVD) parameter, and β_3 is the third-order dispersion coefficient, which becomes significant for ultranarrow signaling pulses, as detailed in [24]. Considering the term $\hat{N}$ in (2), ξ describes the fiber's nonlinearity, ω_0 is the angular frequency of the carrier wave, and T_R is related to the slope of the Raman gain spectrum, as detailed in [22]. In the case of having a pulsedwidth of $T_0 > 5$ frame/s, which is typical for telecommunication fibers [22], the first term of $\hat{D}$ and the last two terms of $\hat{N}$ may be neglected [22]. These simplifications allow us to focus our attention on the nonlinearity and dispersion effects in this paper; hence, the fiber loss parameter is assumed to be $\alpha = 0$. Then, (2) may be further simplified to

$$\frac{\partial A}{\partial z} = \left(-i\frac{\beta_2}{2} \frac{\partial^2}{\partial t^2} + i\xi |A|^2 \right) A = (\hat{D}' + \hat{N}') A \quad (3)$$

where terms $\hat{D}'$ and $\hat{N}'$ are the simplified forms of the dispersion character $\hat{D}$ and the nonlinear character $\hat{N}$ in (2).

More explicitly, the general formula of (2) or its simplified form in (3) describes the pulse propagation problem [22], but in this form, it is not directly suitable for analyzing how the throughput of the wireless link is affected by the parameters of the imperfect optical fiber backhaul. The more practical SSF may be applied for analyzing the solutions of the NLS equation [22], which has been considered for modeling the optical-fiber communication systems [25]. Hence, we employ the SSF method for jointly analyzing the attainable throughput of the DFO link. The SSF method delivers an approximate numerical solution, where the dispersive and nonlinear effects observed in (3) may be separated into independent phenomena over a small segment length l stretching from z to $(z + l)$ in (3), yielding

$$A(z + l, t) \approx F_T^{-1} \left\{ \exp \left[l \hat{D}'(-i\omega) \right] F_T \left[\exp(l \hat{N}') A(z, t) \right] \right\} \quad (4)$$

where F_T and F_T^{-1} denotes the Fourier-transform and inverse Fourier-transform operation, respectively. First, the exponential nonlinearity-related term $\exp(l \hat{N}')$ of (4) may be directly taken into account in the time domain. Second, before characterizing the dispersive effects, we take the Fourier transform of the term $\exp(l \hat{N}') A(z, t)$ since the exponential dispersion-related term $\exp(l \hat{D}')$ may be evaluated in the frequency domain. The Fourier transform of the dispersion character $\hat{D}'$ is obtained by replacing the operator $\partial/\partial t$ by $-i\omega$ in (3). Then, following the inverse Fourier transform of (4), we obtain the time-domain representation of the received signal after propagating through the l -length fiber. The total optical fiber length satisfies $L = ml$, which suggests that the whole fiber length is decomposed into m consecutive l -length segments. Hence, the optical pulse propagating through an L -length fiber may be obtained by evaluating (4) in m consecutive steps, yielding a solution denoted as A_L .

III. RECEIVED SIGNAL OF DFO-AIDED DAS WITH FFR SYSTEMS

A. DFO-Aided Noncooperative DAS With FFR System

Focusing our attention on the cell B_0 of Fig. 1, when non-cooperative DASs are employed, the transmit power P_B of the BS and the transmit power P_R of each RA should obey the total transmit power constraint of $P_B + N_r P_R = P$, where P is the full power at the BS of the traditional UFR and FFR scheme.

1) *Received Signal in the Cell-Center Area:* The interference at any MS located at point Z_i in the cell-center area is imposed by the direct wireless links of BSs $\{1, \dots, N_b\}$, with N_b being the number of BSs, which we refer to as inter-BS interference (IBI). Hence, the received signal may be written as

$$y_c = \sqrt{P_B} \psi_{B0} h_{B0} x_0 + \sum_{j=1}^{N_b} \sqrt{P_B} \psi_{Bj} h_{Bj} x_j + n \quad (5)$$

where ψ_{Bj} , h_{Bj} , $j \in [0, N_b]$, and $n \sim \mathcal{CN}(0, \sigma_0^2)$ represent the combined pathloss-plus-shadowing-based large-scale signal attenuation, small-scale fast Rayleigh fading, and complex-valued AWGN, respectively. More explicitly, we jointly consider both the pathloss and the lognormal shadowing component, which is formulated as $\psi_{Bj} = [\rho 10^{(\varsigma(\sigma_s)/10)}]^{1/2}$, $j \in [0, N_b]$, where ρ denotes the pathloss that obeys a predefined pathloss model [26], whereas ς denotes a real-valued Gaussian random variable having a standard deviation of $\sigma_s = 8$ dB [26]. Hence, $G_{Bj} = \psi_{Bj} |h_{Bj}|$ denotes the equivalent channel gain, whereas the SINR of any of the MSs near the cell center is given by

$$\gamma_c = \frac{G_{B0}^2 P_B}{2\sigma_0^2 + \sum_{j=1}^{N_b} G_{Bj}^2 P_B} \quad (6)$$

2) *Received Signal in the Cell-Edge Area:* When considering the cell-edge area, we assume that the links spanning from the BS B_0 of Fig. 1 to the RAs are constituted by a realistic imperfect optical fiber, whereas the last-mile connection from the RAs to the MS relies on the wireless link. The signal received at RA i after passing through the realistically modeled optical fiber is introduced in Section II-B.

The noise-contaminated faded signal s_i , $i \in [1, N_r]$, denoted in (1) at the wireless channel's input is normalized by a power-scaling factor and then forwarded through the wireless channel to the destination, i.e., to the MS roaming in the cell-edge area, where the power-scaling factor χ is employed to maintain a constant transmit power at the RAs. As a result, the signal received by MS i at any point Z_i in the cell-edge area in the absence of any cooperative techniques may be written as

$$y_{ei} = \sqrt{P_R} \psi_{Ri} h_{Ri} \chi s_i + \sum_{k=1, k \neq i}^{N_r} \sqrt{P_R} \psi_{Rk} h_{Rk} \chi s_k + n. \quad (7)$$

Let $A = \chi A_L$ and $N_f = 2\sigma_f^2 \chi^2$ denote the equivalent optical-fiber-induced amplitude attenuation and the equivalent power spectral density of the optical fiber noise, respectively. The details of parameters s_i and A_L are introduced in

Section II-B. Then, the SINR at any MS roaming in the cell-edge area is

$$\gamma_{ei} = \frac{G_{Ri}^2 A^2 P_R}{2\sigma_0^2 + \sum_{i=1}^{N_r} G_{Ri}^2 N_f P_R + \sum_{k=1, k \neq i}^{N_r} G_{Rk}^2 A^2 P_R} \quad (8)$$

where $G_{Ri} = \psi_{Ri} |h_{Ri}|$ denotes the equivalent channel gain.

3) *Idealistic Received Signal in the Cell-Edge Area:* We assume the employment of perfect adaptive beamforming, where each MS is served with the aid of a narrow beam. We also assume that the MSs would be served only by the nearest RAs and that their reception is not contaminated by the other RAs; hence, no IRI is received by the MSs roaming in the cell-edge area. Hence, their reception is only contaminated by the noise N_f imposed at the optical fiber receiver. Then, the interference-free upper bound of the SINR can be rewritten from (8) as

$$\gamma_u = \frac{G_{Ri}^2 A^2 P_R}{2\sigma_0^2 + G_{Ri}^2 N_f P_R} \quad (9)$$

4) *Benchmark Systems:* Finally, when the classic UFR technique is employed, the received signal model is described by (5) but bearing in mind that full power P is transmitted by each BS, instead of P_B . When the FFR technique is employed, similarly to the classic UFR, the signal received in the cell-center area is also described by (5). On the other hand, the signal received in the cell-edge area from both the serving BS and the cells using the same frequency band in tier two obeys (5).

B. DFO-Aided Cooperative DAS With FFR

In a multicell multiuser scenario, cooperative DAS techniques may be used to provide high throughput for the MSs roaming near the cell-edge area, particularly for mitigating the worst-case direction problem caused by IRI. To simplify the entire system, only a single omnidirectional antenna is applied for each RA. Nonetheless, when jointly designing TPP matrix $\mathbf{T}$, the N_r cooperative RAs operate in a concerted action as a virtual multiple-input-single-output or virtual multiple-input-multiple-output system. On the other hand, only a single receiver antenna is applied at the MS. We will show that the proposed system architecture is capable of substantially enhancing the throughput achievable in the cell-edge area with the advent of our cooperative TPP-aided FFR scheme.

Notation: The lower case boldface letters and the upper case boldface letters represent the column vectors and matrices, respectively. The superscript $(\cdot)^T$ and the $(\cdot)^H$ denote the transposition and the conjugate transpose, respectively.

1) *Received SINR:* The principle of cooperative DAS schemes is essentially the same as that of cooperative BSs [8], where the transmit signal destined for the MSs is spread over all the N_r cooperative RAs. In the multicell multiuser scenario, there are N_m MSs roaming in the cell-edge area of Fig. 1, which are simultaneously supported by the N_r RAs ($N_r = N_m$). Provided that the different propagation delays of all the N_r RA links measured with respect to all the served N_m

MSs can be precompensated, the vector of received signal can be written as

$$\mathbf{y} = \mathbf{H}\mathbf{T}\mathbf{x} + \mathbf{n} \quad (10)$$

where $\mathbf{y}_{N_m \times 1}$ and $\mathbf{n}_{N_m \times 1}$ denote the received signal vector and the circularly symmetric complex Gaussian noise vector, respectively. Furthermore, $\mathbf{x} = [x_1, x_2, \dots, x_{N_m}]^T_{1 \times N_m}$, and x_i is defined as the signal transmitted from RA i to MS i . More explicitly, $x_i = \chi_i s_i$, $i \in [1, N_r]$, represents the signal passing through the realistic "lossy" optical fiber, where χ_i and s_i are the same as those defined in Section III-A2. If the central BS has an estimate of the channel matrix $\mathbf{H} = [\mathbf{h}_1^T, \mathbf{h}_2^T, \dots, \mathbf{h}_{N_m}^T]_{N_m \times N_r}$, we can design a transmit matrix $\mathbf{T}$ for mitigating the IRI, where $\mathbf{T} = [\mathbf{t}_1, \mathbf{t}_2, \dots, \mathbf{t}_{N_m}]_{N_r \times N_m}$ is uniquely and unambiguously determined by $\mathbf{H}$. We also have a dedicated TPP matrix $\mathbf{T}$, which obeys the per RA power constraint of

$$\mathbf{T}_{i,\forall} \mathbf{T}_{i,\forall}^H \leq \frac{P - P_B}{N_r} \quad (11)$$

where $\mathbf{T}_{i,\forall}$ is the row vector of matrix $\mathbf{T}$.

Furthermore, $\mathbf{h}_i = [\psi_1 h_{i1}, \psi_2 h_{i2}, \dots, \psi_{N_r} h_{iN_r}]_{1 \times N_r}$, $i \in [1, N_m]$, represents the channel of all the N_m RAs to MS i links, which takes into account both the large-scale signal attenuation and the small-scale fast Rayleigh fading channel, where ψ_i and h_i are the same as those defined in Section III-A2. Hence, a unified discrete-time model for the signal received by MS i may be formulated based on (10) as

$$y_i = \|\mathbf{h}_i \mathbf{t}_i\| x_i + \sum_{k \neq i} \|\mathbf{h}_i \mathbf{t}_k\| x_k + n_i. \quad (12)$$

When we have $k \neq i$, x_k is the IRI imposed by the transmit signal intended for MS k but received at MS i . Hence, the DFO links' SINR encountered at MS i in the cell-edge area may be written as

$$\gamma_i = A^2 \mathbf{h}_i \mathbf{t}_i \mathbf{t}_i^H \mathbf{h}_i^H \times \left[2\sigma_0^2 + \underbrace{N_f \mathbf{h}_i \mathbf{t}_i \mathbf{t}_i^H \mathbf{h}_i^H}_{\text{IRI}_2} \right]^{-1} + \underbrace{(A^2 + N_f) \mathbf{h}_i \left(\sum_{k \neq i} \mathbf{t}_k \mathbf{t}_k^H \right) \mathbf{h}_i^H}_{\text{IRI}_1} \quad (13)$$

where A and N_f represent the equivalent optical fiber attenuation factor and the equivalent power spectral density of the optical fiber noise, respectively, as defined in Section III-A2. It can be seen from (13) that, for MS i , the IRI is composed of two terms. Specifically, the term IRI_1 of (13) is the desired signal of MS $k \neq i$ that is also contaminated by the optical fiber link's noise N_f , which can be mitigated by appropriately designing the corresponding TPP matrix. The other term, i.e., IRI_2 of (13), is the optical fiber link's noise contaminating the desired signal of MS i , which is self-inflicted noise; hence, the TPP matrix is unable to mitigate it.

2) *Linear Transmit Processing*: Again, we assume that there is only a single transmit antenna at each RA and a single receive antenna at each MS; hence, our system is fully described by the number of RAs N_r and the number of MSs N_m served. Hence, our design is based on the $(N_m \times N_r)$ -element channel matrix $\mathbf{H}$ associated with the central BS, and the TPP facilitates a low-complexity matched-filter-based receiver design at each MS. Our linear TPP matrix $\mathbf{T}$ may be written as

$$\mathbf{T} = \mathbf{G} \cdot \mathbf{W} \quad (14)$$

where $\mathbf{W}_{N_m \times N_m}$ is a diagonal matrix representing the power [8] allocated for each RA, and $\mathbf{G}_{N_r \times N_m}$ is the linear TPP matrix jointly designed on the basis of $\mathbf{H}$. The TPP matrix $\mathbf{G}$ can be calculated with the aid of different linear preprocessing algorithms. In this paper, we consider the minimum mean square error (MMSE) beamformer [27] and the eigenbeamformer (egBF) [28] as our design example.

The classic MMSE beamforming technique strikes an attractive tradeoff between the achievable interference cancellation and noise enhancement; hence, it is attractive for practical applications. The TPP weight matrix $\mathbf{G}_{\text{MMSE}} = \mathbf{H}^H (\mathbf{H}\mathbf{H}^H + (2\sigma_0^2/P_R)\mathbf{I})^{-1}$, which is entirely based on channel matrix $\mathbf{H}$, remains unaffected by the transmit signal. The employment of TPP matrix $\mathbf{G}_{\text{MMSE}}$ mitigates the IRI_1 component in (13), eliminating the interference inflicted on the desired signal.

In cooperative egBF, the TPP matrix $\mathbf{G}_{\text{BF}} = [\mathbf{g}_1, \mathbf{g}_2, \dots, \mathbf{g}_{N_m}]$ is used, where $\mathbf{g}_i$, $i \in [1, N_m]$ is the right-hand-side singular vector of $\mathbf{H}$, which only achieves a power gain, whereas the mitigation of the term IRI_1 in (13) is dependent on the instantaneous geographic distribution of the users. Hence, the mitigation of the IRI_1 cannot always be achieved by appropriately selecting the direction of the transmitted beam, unless we employ an idealistic infinitesimally narrow beam for each MS. The associated performance will be characterized in Section IV-E.

However, in contrast to the IRI_1 , the link's self-noise imposed by the optical fiber receiver's noise contribution, i.e., the IRI_2 terms of (13) cannot be mitigated by the TPP matrix employed, regardless of whether the cooperative MMSE or the cooperative egBF is used. In fact, the self-interference may even be boosted when the desired signal of MS i is amplified.

C. System Throughput

Let us now demonstrate how these SINR expressions may be mapped to the ultimate system performance metric formulated in terms of the achievable throughput η . The throughput may be characterized by the maximum *successfully transmitted* information rate, which is referred to as the system's *goodput*, i.e.,

$$\eta(\gamma) = R_M R_C [1 - P_{\text{bl}}(b, \gamma)] \quad (15)$$

where γ may represent γ_c of (6), γ_{ei} of (8), or γ_u of (9); R_M denotes the "rate," i.e., the throughput of the modulation scheme; and R_C is that of the channel code. Still referring to (15), $P_{\text{bl}}(b, \gamma)$ represents the BLock Error

Ratio (BLER) corresponding to the particular MCS employed. In this paper, we assume that bit-interleaved coded modulation (BICM) [29] is employed, which relies on Gray-mapped M -ary quadrature amplitude modulation (QAM) [30], where we have $M = 2^b$ and $b = 2, 4, 6$ represents the number of bits per QAM symbol. Hence, the modem's throughput is $R_M = b$. In our paper, we employ 2^b -ary QAM combined with rate-compatible punctured codes (RCPCs) [31] having six selected MCSs, i.e., Mode $[1, \dots, 6]$ of $[R_M, R_C] = [(2, 1/2), (2, 3/4), (4, 1/2), (4, 3/4), (6, 2/3), (6, 6/7)]$.

In practice, obtaining the BLER curves for all the MCSs by simulation is time consuming, particularly in our multicell multiuser system-level evaluations. Let us hence circumvent this time-consuming process with the aid of a more efficient semianalytical process. We commence by briefly highlighting the derivation of the BLER $P_{bl}(b, \gamma)$ of a 2^b -ary QAM-aided BICM scheme based on the BLER $P_{bl}(b = 1, \gamma_0)$ of a binary phase-shift keying (BPSK) modulated BICM scheme transmitting over an AWGN channel, where only $P_{bl}(b = 1, \gamma_0)$ is evaluated by simulation. To this effect, we first define the appropriate *baseline* SINR γ_0 as that of a binary BPSK scheme, at which we have the same BLER as an arbitrary b -bit/symbol modem, which would typically require an SINR of $\gamma > \gamma_0$, i.e., where we have $P_{bl}(b, \gamma) = P_{bl}(b = 1, \gamma_0)$. We note that the aforementioned BLER equality holds only when the mutual information (MI) per bit output by the demodulator obeys the relation of $I(b, \gamma) = I(b = 1, \gamma_0)$. This is because I serves as the input of the channel decoder, and as long as I remains the same, the ultimate BLER also remains the same. Hence, the MI I per bit may be expressed as [29]

$$I(b, \gamma) = 1 - \frac{2^{-b}}{b} \sum_{i=1}^b \mathbb{E}_w \left\{ \ln \left[1 + \sum_{j=1, j \neq i}^b \exp \left(-\frac{|u_j - u_i + w|^2 - |w|^2}{1/\gamma} \right) \right] \right\} \quad (16)$$

where $w \sim \mathcal{CN}(0, 1/2\gamma)$ is the complex-valued zero-mean Gaussian noise process, and $u \in \mathcal{A}$ represents the constellation points in the QAM alphabet, with the i th bit $\mathcal{A}$ being represented by $u_i, i \in [1, b]$. When fixing the MI per bit as $I(b, \gamma) = I(b = 1, \gamma_0)$, we may find the *baseline* SINR γ_0 for $b = 1$, where this BPSK modulated scheme achieves the same per-bit MI I as a higher throughput 2^b -ary QAM-aided BICM scheme. More explicitly, the MI per bit $I(b = 1, \gamma_0)$ is a monotonically increasing function of γ_0 , and its unique inverse exists. Hence, this *baseline* SINR γ_0 may be expressed as the inverse function $\gamma_0 = I^{-1}[b = 1, I(b, \gamma)]$. This reveals the relation between γ and γ_0 , allowing us to find the BLER $P_{bl}(b, \gamma)$ of a 2^b -ary QAM-aided BICM scheme from that of the simulated BLER of a BPSK modulated BICM scheme, i.e., from $P_{bl}(b = 1, \gamma_0)$, which may be formulated as

$$P_{bl}(b, \gamma) = P_{bl} \{b = 1, I^{-1}[b = 1, I(b, \gamma)]\}. \quad (17)$$

As a result, the BLER $P_{bl}(b, \gamma)$ of the aforementioned MCSs may be obtained with the aid of (17), where $P_{bl}(b = 1, \gamma_0)$ is

obtained from the Monte Carlo simulation of a BPSK modulated BICM scheme employing the aforementioned RCPC having constituent code rates of $R_C = [1/2, 3/4, 2/3, 6/7]$ in an AWGN channel. Finally, the associated effective throughput $\eta(\gamma)$ of (15) expressed in terms of "bits per second per hertz" may be obtained by assuming a Nyquist rolloff factor of zero. Owing to space limitations, the detailed link-level simulation results are not explicitly shown here.

IV. PERFORMANCE EVALUATION

A. Simulation Assumptions

The system topology considered is shown in Fig. 1, where each hexagonal cell has a radius of R , and the distance between the two adjacent BSs is $D = \sqrt{3}R$, e.g., $\overline{B_2 B_3} = \sqrt{3}R$. We considered the Urban-Macro propagation scenario of [26], where we have $D = 3$ km and the distance-dependent pathloss expressed in decibels is $34.5 + 35 \log_{10}(d_0)$, with d_0 being the distance between any transmitter and receiver in meters. We assume furthermore that the total transmitter power is $P = 46$ dBm and that the noise power at the MS is -174 dBm/Hz, when operation in a bandwidth of 10 MHz is considered [26]. Moreover, the optical fiber link's normalized signal-to-noise ratio is assumed to be 50 dB and the length of the optical fiber is assumed to be five times the distance between the BS and RA, where we have $L = 5d$ and d is the line-of-sight distance. We opted for $d = 0.7R, \forall i$.

The cell-center area's radius r may be defined as the maximum radius, where a throughput of at least $\eta = 2$ bit/s/Hz may be maintained in a conventional cellular system employing the classic UFR technique, but beyond this coverage radius, it drops below $\eta = 2$ bits/s/Hz. When employing DASs in an FFR-based cellular system, the transmit power of the BS should be sufficiently high to ensure that the average throughput maintained at a distance of r remains exactly as high as that of the classic UFR technique, whereas the rest of the power is evenly allocated to the RAs. Hence, when considering the $N_r = 6$ RAs operating in a noncooperative DAS-aided FFR scenario, the resultant power sharing regime of all the transmitters obeys $P_B = 2P/5$, whereas, for the relay, we have $P_R = P/10$. By contrast, when considering the $N_r = 6$ RAs operating in a cooperative DAS-assisted FFR scenario, the power constraint of (11) is applied. Finally, the ultimate throughput is obtained by averaging the SINR over 4000 simulation runs and then substituting it into (15) and (17).

B. Propagation Regimes in the DFO Link

Before detailing our results, the propagation scenario encountered has to be introduced. When the pulses propagate along the optical fiber, both the nonlinearity and the dispersion depend on the peak power P_0 and on the initial width T_0 of the incident pulse. The critical fiber lengths L_N and L_D quantify the length of fiber over which either the nonlinear or the dispersive effects become dominant during the signaling

TABLE I
PROPAGATION REGIMES

Curve	P_0	T_0	l	L_D	L_N
1	10mW	10ps	5m	5km	50km
2	160mW	10ps	5m	5km	3km
3	10mW	10ps	10m	5km	50km
4	10mW	20ps	5m	20km	50km
5	10mW	50ps	5m	125km	50km

pulse's propagation. The relations between L_N and P_0 , and L_D and T_0 are calculated as follows [22]:

$$L_N = \frac{1}{\xi P_0}, L_D = \frac{T_0^2}{|\beta_2|}. \quad (18)$$

The typical values of the GVD parameter β_2 and the nonlinearity parameter ξ at a wavelength of $1.55 \mu\text{m}$ are [22] $|\beta_2| \approx 20 \text{ ps}^2/\text{km}$ and $\xi \approx 2 \text{ W}^{-1}\text{km}^{-1}$ for standard telecommunication fibers. For a given optical fiber length of L , we have four conditions that hold.

- 1) If $L \ll L_N$ and $L \ll L_D$, neither the nonlinear nor the dispersive effects impose a significant performance degradation during the pulse's propagation.
- 2) If $L \ll L_N$ and $L \sim L_D$, the nonlinear effects may be ignored, and the dispersion will play the dominant role.
- 3) For $L \sim L_N$ and $L \ll L_D$, the dispersion is negligible compared to the nonlinear distortion.
- 4) For $L \sim L_N$ and $L \sim L_D$, both of the nonlinear and dispersion effects are nonnegligible.

In this paper, according to the Urban-Macro cell scenario introduced in Section IV-A, we assume the set of P_0 and T_0 values shown in Table I to investigate how the nonlinear and dispersion effects of the optical fiber influence the attainable throughput of the wireless channel in the cell-edge area.

C. Throughput of Cell-Center Area

The attainable throughput of both the noncooperative DAS combined with FFR system (Figs. 3 and 4) and the cooperative DAS combined with FFR (Fig. 6) in the cell-center area relies on the same SINR of (6) introduced in Section III-A. Hence, both of them have the same throughput performance. Explicitly, upon assigning a transmit power of $P_B = 2P/5$ in the cell-center area, the throughput of the noncooperative DAS combined with FFR system and that of cooperative DAS combined with FFR become similar to that of the traditional UFR and FFR systems, provided that the latter two systems assign the full transmit power to the BS.

D. Cell-Edge Area of Noncooperative DAS With FFR

Figs. 3 and 4 compare the throughput of the classic UFR system, the traditional FFR system, and the noncooperative RA-aided FFR-assisted systems using $N_r = 6$ and $N_m = 6$ in the best and worst directions in a two-tier scenario. The four sets of optical fiber parameters shown in Table I were used.

1) *Throughput Along Best Direction:* By contrast, when the cell-edge area is considered, observe in Figs. 3 and 4 that the throughput of the conventional UFR scheme becomes

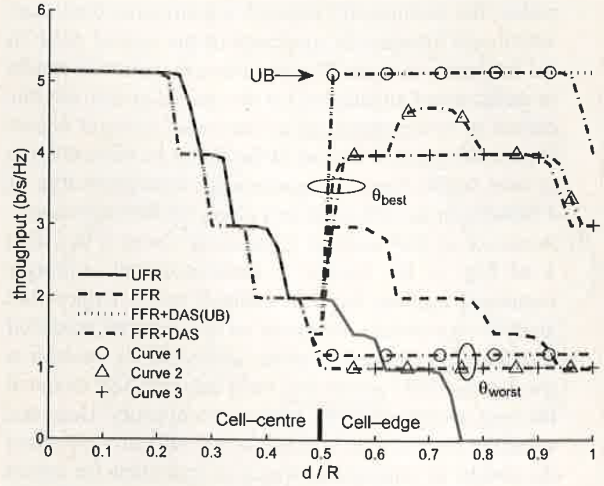


Fig. 3. Throughput comparison of the traditional UFR system, FFR system, and the $N_r = 6$ noncooperative DAS-aided FFR system in two-tier scenarios along the θ_{best} and θ_{worst} directions recorded for characterizing the nonlinear effects of the optical fiber and the accuracy of the SSF method.

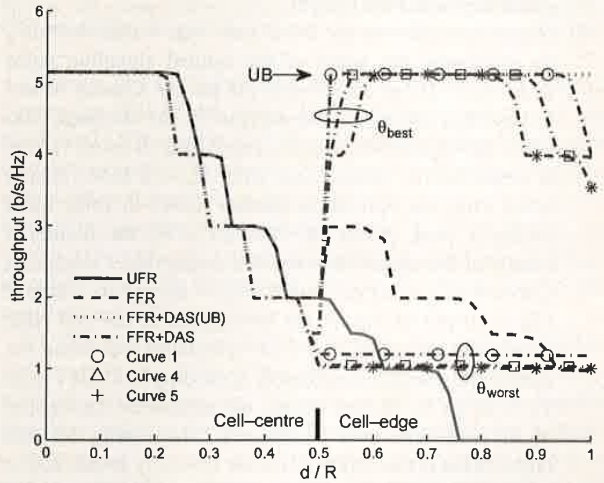


Fig. 4. Throughput comparison of the traditional UFR system, FFR system, and the $N_r = 6$ noncooperative DAS-aided FFR system along the θ_{best} and θ_{worst} directions for characterizing the dispersion effects of the optical fiber.

lower than $\eta = 2 \text{ bit/s/Hz}$, whereas that of the conventional FFR scheme is in the range of $\eta \in [1, 3] \text{ bit/s/Hz}$. When the noncooperative RA-aided FFR-assisted system is employed in conjunction with $N_r = 6$ RAs, a throughput in the range of $\eta \in [3, 5] \text{ bit/s/Hz}$ is achieved along the best direction.

More explicitly, when using the parameters of Table I, Curves 1–5 in Figs. 3 and 4 suggest three conditions.

- 1) *Nonlinear effect of the DFO link:* The comparison of Curve 1 ($P_0 = 10 \text{ mW}$) and Curve 2 ($P_0 = 160 \text{ mW}$) in Fig. 3 shows how the power assigned to the optical pulses affects the throughput of the wireless link, which was demonstrated by setting $P_0 = 10 \text{ mW}$ and 160 mW of peak power for the optical signaling pulse. Again, the corresponding optical parameters are shown in Table I. Observe by comparing Curves 1 and 2 of Fig. 3 that assigning a $P_0 = 160 \text{ mW}$ power to the optical pulse

makes the nonlinearity-induced impairments dominant, which will broaden the spectrum of the optical pulse in the frequency domain. The nonlinearity indirectly results in an increased attenuation for the optical pulses, but this cannot be compensated by an increased transmit power. Hence, this leads to a boost of the IRI. As a net result, the system suffers from an approximate throughput loss of 1 bit/s/Hz in the cell-edge area along the best direction.

- 2) *Accuracy of SSF method:* Comparing Curve 3 to Curve 1 of Fig. 3, the former is associated with a longer segment l used by the SSF method, which reduces the analysis complexity. However, as a result, the predicted throughput is reduced by about 1 bit/s/Hz. By contrast, a shorter segment l results in a more accurate SSF model at the cost of higher offline analysis complexity. However, selecting the probable segment length will strongly affect the results of simulation, which is important for whom doing the relative research. For a typical urban cell size, our Monte Carlo simulation results suggest that $l = 5$ m is an appropriate compromise, which may be trusted as the real attainable throughput of our DFO-aided DAS combined with FFR system.
- 3) *Dispersion effect of the DFO link:* Fig. 4 demonstrates, by increasing the width of the optical signaling pulse from $T_0 = 10$ ps to 20 and 50 ps for Curves 4 and 5, how this affects the throughput of the wireless link, when the noncooperative RA-aided FFR-assisted system is employed in conjunction with $N_r = 6$ RAs. Again, when using the optical parameters shown in Table I and setting a peak power of $P_0 = 10$ mW, the nonlinear effects of the optical fiber become negligible. Comparing Curve 4 ($T_0 = 20$ ps) and 5 ($T_0 = 50$ ps) to Curve 1 ($T_0 = 10$ ps) of Fig. 4, the throughput at the cell edge remains in the range of $\eta \in [4, 5]$ bit/s/Hz, but when the optical pulsewidth is increased, according to Table I from $T_0 = 10$ ps to 20 and 50 ps, the attainable throughput of the cell-edge area is reduced. The reason for this observation is that wide pulses are typically broadened to a lesser relative degree along the optical fiber, which also leads to a reduced attenuation at both the optical receiver of the serving RA and the interfering RAs.

2) *Throughput Along Worst Direction:* When considering the worst direction in both Figs. 3 and 4, regardless of the specific choice of the five parameter sets of Table I, we only achieve a throughput of about $\eta = 1$ bit/s/Hz. This is due to the aforementioned worst-case direction problem [6], which becomes the limiting factor in the case of the conventional noncooperative RA-aided FFR-assisted system.

3) *Comparison of the Entire Cell's Throughput:* Fig. 5 shows the attainable throughput across the entire cell for the different configurations of our noncooperative RA-aided FFR-assisted system associated with Curve 1 of Table I. More explicitly, the cell-center area's throughput contours recorded in Fig. 5 for both configurations are similar. However, the throughput distribution of the $N_r = 6$ RA-aided configuration recorded for the cell-edge area tends to be more "patchy," whereas that of the $N_r = 12$ RA-assisted configuration tends

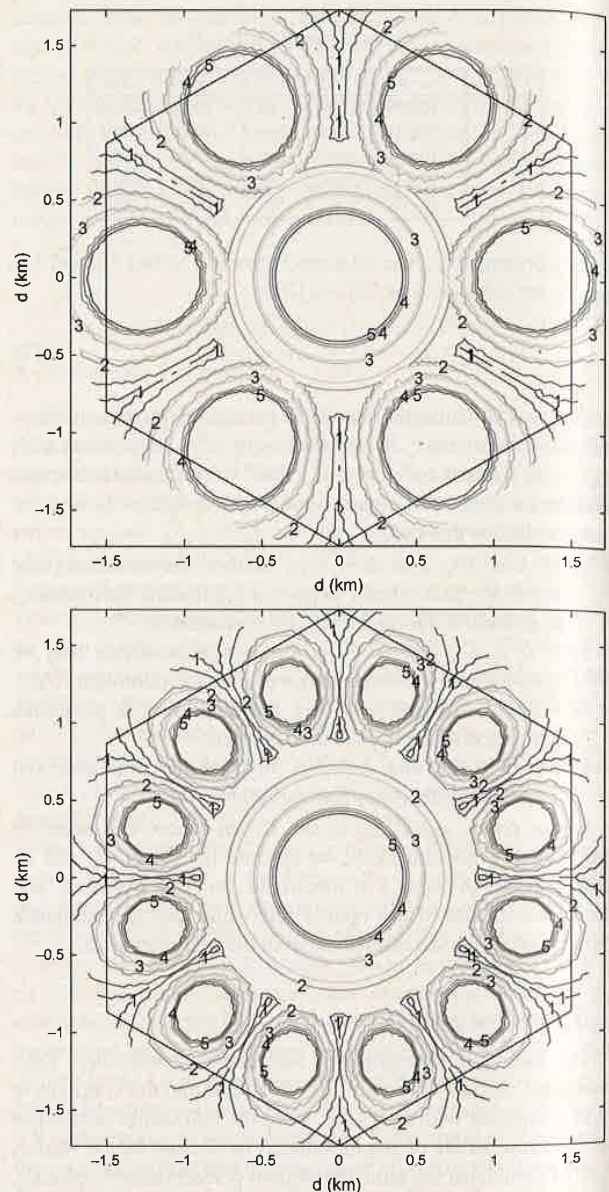


Fig. 5. Throughput contours for the $N_r = 6$ and $N_r = 12$ noncooperative DAS-aided FFR system.

to more evenly cover the entire outer ring. As a result, the general conclusion emerging for the comparison of these two configurations is that the optimum positioning of DASs should take into account the expected user distribution and user load. However, the "worst-case direction" problem persists in both of these two configurations.

E. Cell-Edge Area of Cooperative DAS With FFR

Fig. 6 compares the throughput of the classic UFR-based arrangement and the traditional FFR-aided system, as well as that of the cooperative RA-aided FFR-assisted system using $N_r = 6$, which was evaluated along both the best and worst

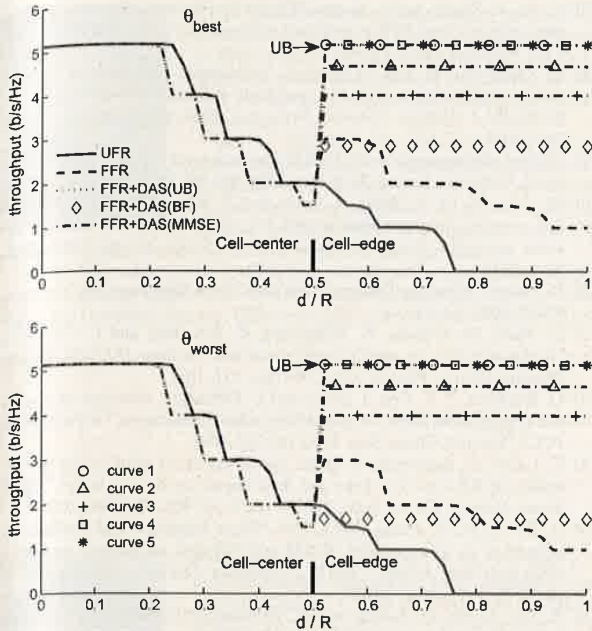


Fig. 6. Throughput comparison of the traditional UFR system, FFR system, and the $N_r = 6$ cooperative DAS-aided FFR system along the best direction with five sets of optical parameters in Table 1 a multicell multiuser scenario. The legends are shared between the top and bottom graphs.

angular directions, respectively, and employing the five sets of parameters seen in Table I for the optical fiber link. We consider supporting $N_m = 6$ MSs roaming in the cell-edge area, where MS i is close to RA i . The N_m MSs are simultaneously served by the N_r cooperative RAs, and they are randomly distributed around the point Z_i , $i = 1, \dots, N_m$, of Fig. 1, where Z_i belongs to the corresponding 60° -sector surrounding RA i . The MSs are allowed to randomly cross the cell-edge area, but only once, to investigate the histogram of the attainable throughput for the N_m MSs.

1) *Throughput Along the Best Direction:* When the cell-edge area is considered, observe the upper figure in Fig. 6 that the throughput of the conventional UFR scheme becomes lower than $\eta = 2$ bits/s/Hz, whereas that of the conventional FFR scheme is in the range of $\eta \in [1, 3]$ bits/s/Hz. When the cooperative RA-aided FFR-assisted system using the parameters associated with Curves 1, 4, and 5 of Table I is considered, observe in Fig. 6 that linear TPP achieves a throughput of $\eta = 5$ bit/s/Hz, which is similar to the throughput upper bound of the RA-aided FFR-assisted system. Hence, when the nonlinearity effects can be ignored, the dispersion does not overly affect the throughput of the wireless channel.

Comparing Curves 2 and 1 in Fig. 6, when using a peak power of $P_0 = 160$ mW for the signaling pulses, the MMSE TPP techniques achieve a slightly higher throughput than 4 bit/s/Hz. Since the term IRI_1 in (13) is mitigated by the MMSE TPP, the throughput reduction is imposed by further attenuation of the received optical signaling pulses inflicted by the fiber's nonlinearity. When employing the parameters associated with Curve 3 with a segment length of $l = 10$ m for the SSF method, a throughput reduction of $\Delta\eta = 1$ bit/s/Hz is encountered.

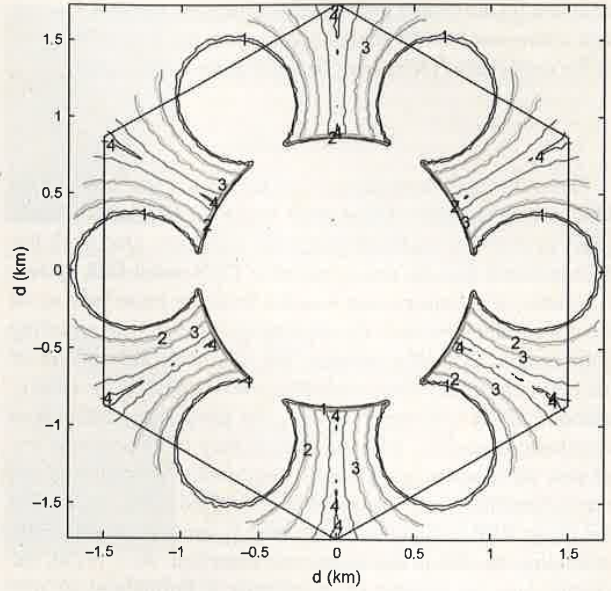


Fig. 7. Enhancement of throughput $\Delta\eta$ contours for the $N_r = 6$ cooperative DAS-aided FFR systems, comparing with the noncooperative DAS-aided FFR.

Observe in Fig. 6 that the throughput of cooperative egBF is between that of the linear TPP techniques and that of the traditional UFR system, and it is not always higher than that of the conventional FFR scheme. The reason for this phenomenon is that the performance of the cooperative egBF is also dependent on the geographic distribution of the N_m users. Hence, the served MS may suffer from an increased interference, which imposes increased throughput erosion in comparison to the conventional FFR scheme.

2) *Throughput Along Worst Direction:* It is demonstrated in the lower figure of Fig. 6 that the cooperative RA-aided FFR-assisted system does not suffer from the worst-case angular direction problem; hence, the linear TPP techniques achieve a throughput of $\eta = 5$ bit/s/Hz, which is the upper bound of the RA-aided FFR-assisted system. The other curves exhibit the same throughput performance as that shown in the upper figure of Fig. 6. The cooperative egBF does not solve the worst-case angular direction problem; hence, its throughput is lower than that of the traditional FFR.

F. Enhancement of Throughput Across the Entire Cell

To observe the attainable throughput improvement $\Delta\eta$ achieved by the cooperative RA aided FFR-assisted systems over their noncooperative counterparts across the entire cell, the resultant throughput contour profile associated with Curve 1 of Table I is shown in Fig. 7. We configured the cooperative techniques for enhancing the attainable throughput in the cell-edge area; hence, in the cell-center area, we have $\Delta\eta = 0$. In the cell-edge area, when considering the cooperative MMSE arrangement for example, there is a significant throughput improvement in the worst-case angular direction since we have $\Delta\eta = 4$ bit/s/Hz in the direction θ_{worst} . By contrast, when the MS is roaming close to the RA, the throughput improvement

achieved by the cooperative MMSE technique remains limited. When however the MS is roaming far from the RA, the benefits of the cooperative techniques become more pronounced.

V. CONCLUSION

The achievable throughput of a DFO-aided DAS relying on FFR and a realistic optical fiber backhaul has been investigated in practical multicell multiuser scenarios. Our work has demonstrated that the noncooperative DAS-aided FFR system is capable of gleaning some benefits from the imperfections of the optical fiber, because the dispersion of the optical signaling pulse might indirectly increase the attainable throughput of the cell-edge area. More explicitly, when applying the configurations of $N_r = 6$ and $N_r = 12$, the geographic throughput distribution becomes different, which may be beneficially exploited for supporting different geographic user distributions. Correspondingly, the cooperative RA-aided FFR relying on the linear TPP techniques¹ advocated is capable of efficiently mitigating the IRI in the worst-case direction. As a result, the system may be capable of supporting a throughput of $\eta = 5$ bits/s/Hz, regardless of the specific geographic user distribution encountered. Furthermore, the cooperative RA-aided FFR system may become tolerant to the dispersion of the optical pulse but sensitive to fiber-induced nonlinearity, if the optical pulse has a high power.

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¹ Indeed, efficient TPP requires efficient feedback control, which involves accurate and frequent channel estimation, quantization, and feedback process, where sophisticated signal processing improvements may result in increased throughput. The overhead associated with this cooperative transmission, or closed-loop design in general, is constituted by the Doppler-dependent channel-sounding pilot overhead and the feedback quantization overhead, where the latter potentially depends on not only the quantization method performed but also the specific cooperative structure employed, i.e., whether centralized or distributed cooperation is used. Regarding the effect of the numbers of RAs, an intuitive observation is that the more cooperative the RAs, the more the overhead that will be incurred. However, no simple quantitative relationship may be established. Furthermore, since the amount of overhead imposed may offset the potential gain achieved, we have to strike an attractive tradeoff, as discussed in [32]. The rate of change of the channel will indeed significantly decrease the resultant performance gains since the feedback may become more outdated and the preprocessing matrix will be subject to strong mismatch. Hence, closed-loop designs in general may not be suitable for high-velocity applications, where, in addition to an increased normalized feedback delay, the channel estimation becomes more challenging in the downlink.



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EXHIBIT 1006

Agenda Item: 10.2.1
Source: Huawei
Title: Further Analysis of Soft Frequency Reuse Scheme
Document for: Discussion & Decision

1. Introduction

At the RAN1#41 meeting we proposed the soft frequency reuse scheme in [1]. The soft frequency reuse scheme can suppress the inter-cell interference and improve cell edge data rate. It can be employed as one possible solution for inter cell interference mitigation. This contribution further analysis soft frequency scheme by the provision of detailed simulation results. The soft frequency reuse scheme for inter-cell interference mitigation is briefly described in Section 2. The simulation assumptions are given in the Section 3. And then in Section 4, we provide simulation results and basic analysis. Finally, conclusions are drawn in Section 5.

2. Soft frequency reuse scheme for inter-cell interference mitigation

In the proposed soft frequency reuse scheme, sub-carriers are divided into two groups in every cell. One group is called major sub-carriers group, and the other one is called minor sub-carriers group. For each group of sub-carriers, one maximum allowed transmission power is set for them. Normally, the maximum allowed transmission power for major sub-carriers is higher than minor sub-carriers. The transmission power on each sub-carrier shall not exceed this limitation. The major sub-carrier can be used to cover the whole cell area, while the minor sub-carrier is used only in the inner part of the cell, as is showed in figure 1 (the blue represents the inner zones and the other colors represent the cell edges). Major subcarriers in neighboring cell are orthogonal (i.e. no overlap). The so called “Power Ratio” is the ratio between transmit power limitation of minor sub-carriers and major subcarriers. Power Ratio adjusted gradually from 0 to 1, the effective reuse factor changes from 3 to 1 smoothly. So, the SFR is the compromise of reuse 1 and reuse 3.

By adjusting the power ratio, SFR can adapt the variation of the service distribution in each cell. When the high traffic happens at the cell edge, the power ratio should be set to a relatively small value to get a high cell edge bit rate. On the contrary, when the traffic is mainly located at the inner part of the cell, a relatively large value for the power ratio is reasonable.

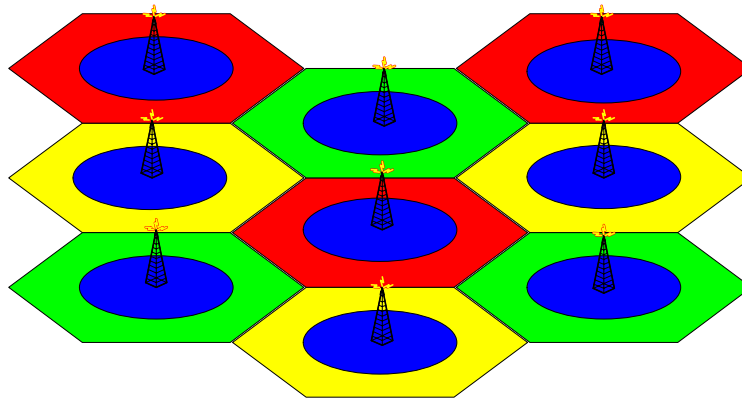


Figure 1, Cell deployment

3. Simulation assumption

Simulation parameters are listed in **Error! Reference source not found.**. These are in-line with 25.814[2].

Parameter	Value
Carrier frequency	2GHz
System bandwidth	5MHz
Cellular Layout	Hexagonal grid, 19 cell sites
Inter-site distance	1000m
Distance-dependent path loss	$L=128.1 + 37.6\log_{10}(R)$, R in kilometers
Lognormal Shadowing	Log Normal Fading with 0 mean, 8dB standard deviation
BS transmit power	43dBm
UE Noise Figure	9dB
Tx antennas (BS)	1
Rx antennas (UE)	1
Traffic model	Full buffer
Link Adaptation	Perfect
Modulation	QPSK and 16-QAM
Coding	Rate 1/3, 1/2, 2/3, 3/4, 4/5 Turbo
Number of total sub-carriers	300
Number of Major sub-carriers	100
Number of Minor sub-carriers	200
UE number per cell	6
Cell edge UE number	2
Inner zone UE number	4
White noise power density	-174 dBm/Hz

Table1: simulation parameters

4. Simulation results

A network with 19 cells, 300 sub carriers per cell and the total bandwidth 5 MHz is used. 100 sub-carriers are defined as major sub-carriers which are assigned only to the cell edge users and the other 200 as minor sub-carrier only to the inner zone users. 1/3 users are uniformly and randomly distributed in cell edge areas (1/3 of the total area), whereas 2/3 users in inner zone. In the simulation, the same number sub-carriers are assigned to each user, the number of UE in each cell is 6, 2 UE is located at so-called cell edge.

The figure 2, 3, 4 shows the cell edge throughput, the inner zone throughput and the total cell throughput varieties curves with the different Power Ratio. The X coordinate represents the transmission power ratio. When the power ratio is 1, the soft frequency reuse scheme is the same as the reuse factor 1, which means that the powers limitation for all the sub-carriers are same, when the power ratio is 0, it is equal to the reuse factor 3, which means that minor sub-carriers do not exist.

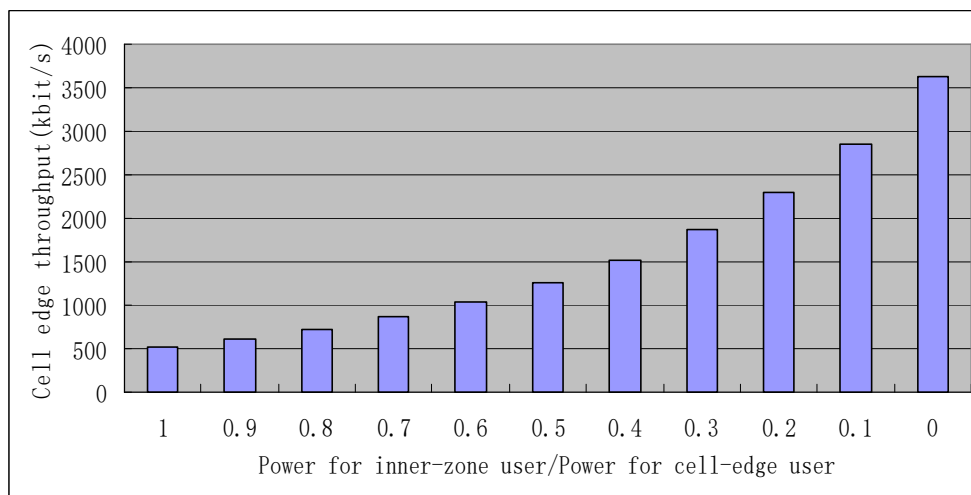


Figure 2, cell edge throughput in soft frequency reuse scheme

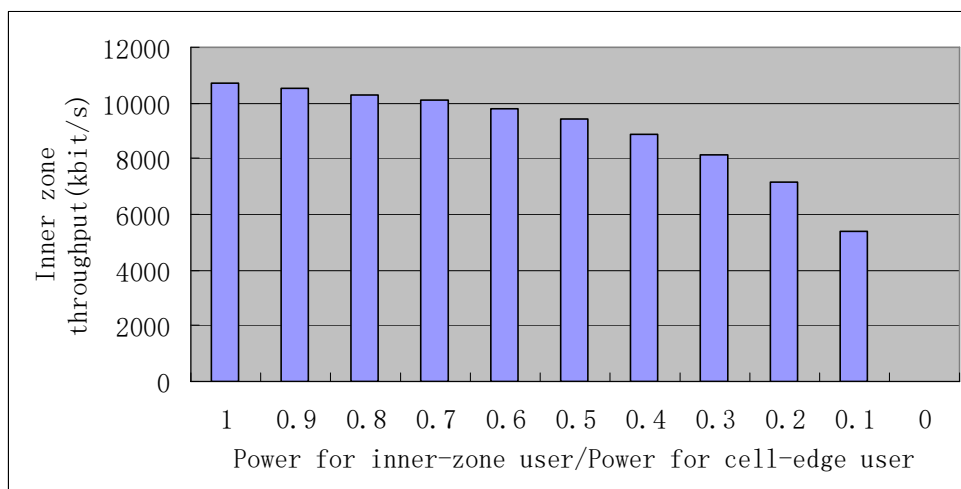


Figure 3, inner zone throughput in soft frequency reuse

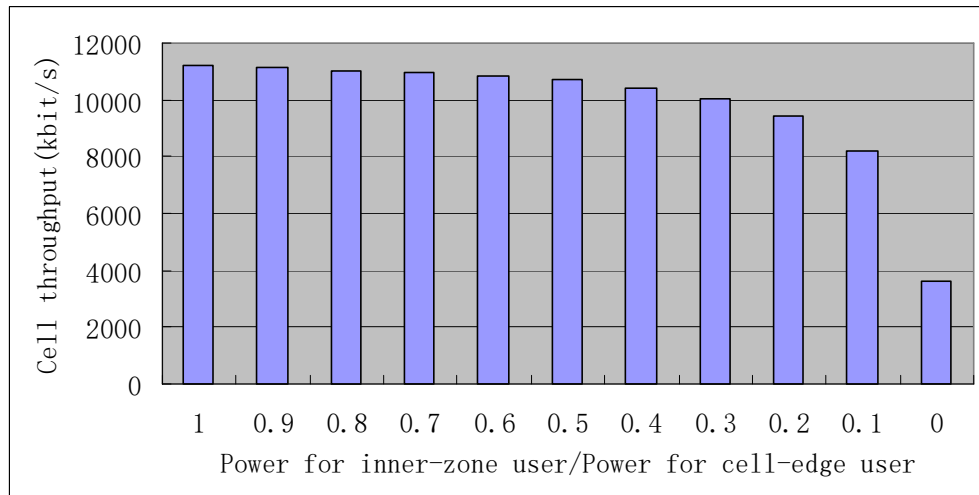


Figure 4, cell throughput in soft frequency reuse scheme

These figures show:

1. When the power ratio decreases, the cell edge throughput increases due to the increasing transmission power for cell edge users and the mitigation of co-channel interference. When the power ratio is 1, the throughput for cell edge is about 500kbit/s, when the power ratio decreases to 0.4, the throughput can reach 1.5Mbit/s, and when the power ratio is 0, the throughput can reach 3.5Mbit/s.

2. When the power ratio decreases, the inner zone throughput decreases. When the power ratio is 1, the inner zone throughput is about 10.7Mbit/s, when the power ratio moves 0.4, the value decreases to 8.9Mbit/s, which decreases 16.8%.

3. When the power ratio decreases, the total cell throughput decreases also. When the power ratio is 1, the total cell throughput is about 11.2Mbit/s, when the power ratio is 0.4, the value decreases to 10.4Mbit/s, which decreases 7.1%. This figure also show that, when power ratio is large that 0.3, the cell throughput reduces slightly along with power ratio decreasing.

Then, we give the CDF curves to illustrate the performance of frequency soft reuse scheme compared with conventional OFDM (Reuse factor =1). In this simulation, we assume the power ratio is 0.4.

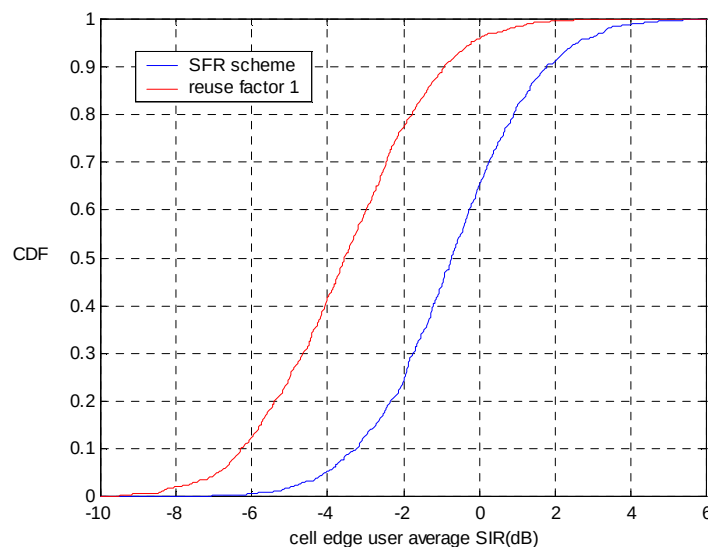


Figure 5, CDFs of the cell edge user average SIR

Figure 5 shows the CDF curves of the cell edge user average SIR with soft frequency reuse scheme and without it. From the figure, the cell edge user average SIR can be improved by 3dB for the probability of 90%.

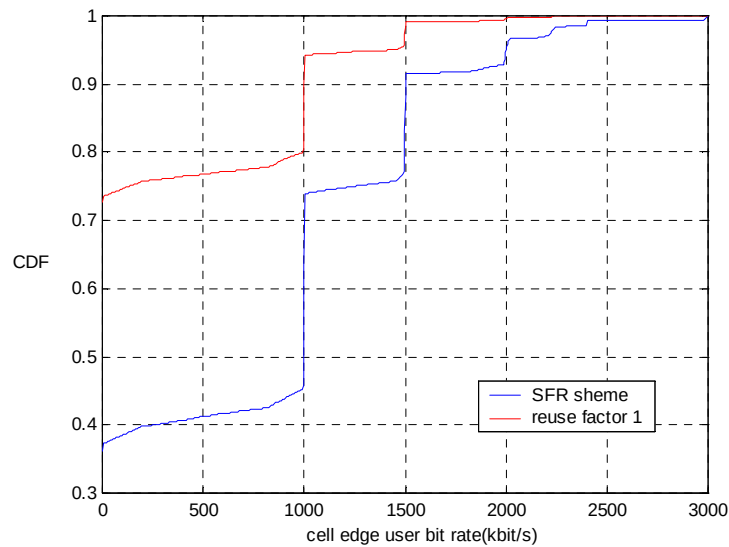


Figure 6, CDF of cell edge user bit rate

Figure 6 shows the CDF curves of the cell edge user bit rate. When CDF value is equal to 0.9, the probability that the cell edge user bit rate is not less than 1.5Mbit/s is 10% for soft frequency scheme, whereas, when reuse factor=1, the corresponding value is only 1Mbit/s.

5. Conclusion

The soft frequency reuse scheme can reduce the inter-cell interference and improve cell edge data rate. By rightly adjusting the power ratio, the soft frequency reuse scheme can adapt the variation of location based traffic distribution. So, we propose that soft frequency reuse scheme should be thought as one candidate solution for inter-cell interference mitigation.

6. Text Proposal

----- Start of Text Proposal -----

7.1.2.6 Inter-cell interference mitigation

Inter-cell interference is suppressed by processing/coding gain in combination with cell-specific scrambling (randomization) of the coded data streams. The alternative use of cell-specific interleaving as a means for randomization should also be considered. Receiver technologies suppressing inter-cell interference may also be considered.

To further reduce the downlink inter-cell interference, constraints can be imposed on the Node B scheduler. The scheduler may e.g. be limited to schedule data only on a sub-set of the total set of sub carriers or have a limit in the allowed maximum transmit power on some sub carriers. If these scheduler constraints are coordinated between cells in such a way that the

sub-sets mentioned above are orthogonal, each cell can then experience reduced inter-cell interference and, potentially, improved cell-edge coverage. This also include means to orthogonalize pilot between cells

Operation with a frequency reuse larger than one should also be considered as part of the Study Item.

The soft frequency reuse scheme, in which effective reuse factor can be changed gradually according to traffic distribution by adjusting power ratio of minor and major sub-carriers, should be considered as a possible solution to suppress inter-cell interference and improve cell edge data rate.

----- *End of Text Proposal* -----

7. Reference

- [1] R1-050507, Soft Frequency Reuse Scheme for UTRAN LTE, Huawei
- [2] TR25.814 v011, “Physical Layer Aspects for Evolved UTRA”, Sophia Antipolis, France, June 2005

EXHIBIT 1007

Source: Ericsson
Title: Inter-cell Interference Handling for E-UTRA
Agenda Item: 10.2
Document for: Discussion and Decision

1. Introduction

The possibility for intra-cell orthogonality, both in uplink and downlink, is supported by most E-UTRA proposals. With orthogonality within the cell, the main interference in an E-UTRA system will be inter-cell interference. It is therefore important to consider what techniques to be used in E-UTRA to handle inter-cell interference.

Three different techniques for mitigating inter-cell interference are discussed in this paper:

- Cell-specific scrambling vs cell-specific interleaving
- Fractional reuse
- Downlink macro diversity

Note that the techniques are not mutually exclusive, but can in many cases be combined.

2. Cell-specific Scrambling/Interleaving for Unicast Transmission

Cell-specific scrambling, briefly illustrated in Figure 1, has been proposed for E-UTRA by several companies as a tool for whitening the inter-cell interference in case of unicast transmission. In principle, scrambling for E-UTRA operates in the same way as for UTRA. Without scrambling, the UE decoder is matched not only to the intended signal, but also to signals intended for users in other cells. This would significantly decrease the performance and scrambling is therefore useful to whiten (randomize) the interference seen by the receiver. The interference suppression capability is proportional to the processing gain, i.e., the code rate of the turbo code in Figure 1. Furthermore, note that scrambling does not affect the bandwidth, i.e., it is *not* a spreading operation. Scrambling can also be applied to the uplink, in which case the scrambling sequence is UE-specific instead of cell-specific.

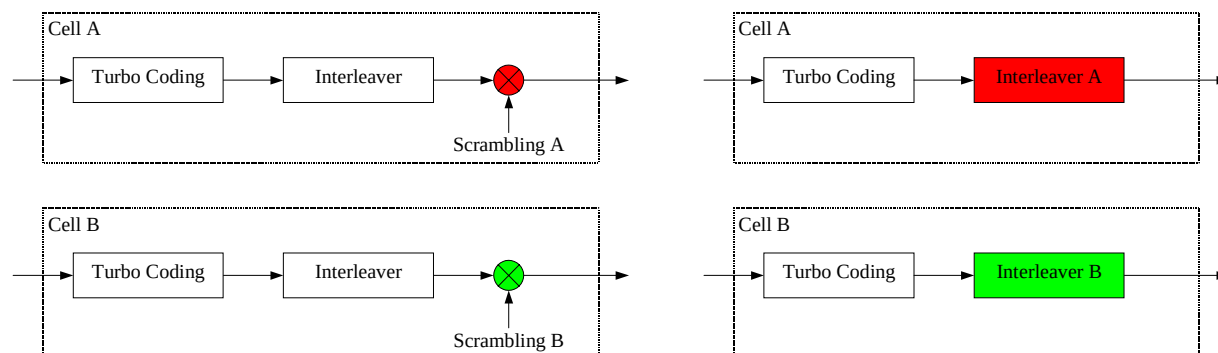


Figure 1: Cell-specific scrambling (left) and cell-specific interleaving (right).

As an alternative to cell-specific scrambling, cell-specific interleaving, also known as IDMA, has been proposed [1]. In this scheme, the signal transmitted in each cell is uniquely interleaved. According to [1], cell-specific interleaving serves two purposes:

- Whitening of the inter-cell interference.
- Improved performance for advanced inter-cell interference cancellation.

On the first aspect, interference whitening of the inter-cell interference, scrambling and interleaving have similar characteristics, although cell-specific scrambling appears somewhat simpler to implement.

On the second aspect, improved performance with advanced interference cancellation, cell-specific interleaving could allow for improved performance with iterative multi-user detection techniques. Such techniques are

interesting and well worth studying further to fully understand the potential gains. For example, techniques to find a sufficiently large number of well-performing interleavers, the performance with Turbo codes in fading channels and methods for reducing the decoder complexity all pose interesting and relevant research problems. The performance in asynchronous networks, when the received signal from the different cells are not time aligned, is another aspect to investigate.

Conclusion: From an interference whitening perspective, the two methods have similar performance and cell-specific scrambling is recommended due to simpler implementation. Cell-specific interleaving with iterative multi-user detection is a promising candidate for further studies.

3. Fractional Reuse

Fractional reuse, also known as soft frequency reuse or interference coordination, has been proposed as a means to increase the performance for cell-edge users [2][3][4]. With fractional reuse, only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with full power using the “blue” part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

The radio resources used for transmission to/from UEs in a cell are controlled by the scheduler in the Node B and fractional reuse can therefore be implemented as part of the scheduling decision. Downlink (uplink) fractional reuse can thus simply be seen as constraints to the downlink (uplink) scheduler. The constraints can either be configured semi-statically by a higher node, e.g., the RNC, or derived and continuously updated by the Node B using an adaptive algorithm (self-configuration). The update rate of the scheduler constraints is typically significantly slower than the TTI rate. Note that there is no direct impact on the physical layer to be taken into account in the design of E-UTRA. Finally, note that the use of fractional reuse is a deployment aspect and can be enabled in the cells where it is beneficial without enforcing it in all cells.

Conclusion: Fractional reuse can increase the performance for cell-edge users. It is recommended to support fractional reuse as part of the scheduler operation.

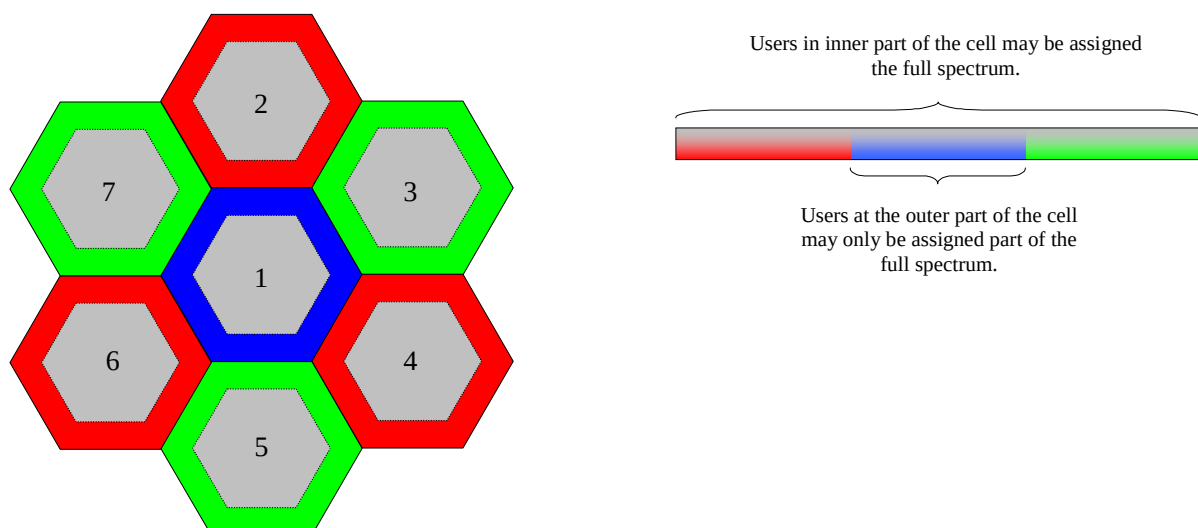


Figure 2: Example illustrating fractional reuse for cell-edge users (a continuous spectrum for the fractional reuse is assumed for illustrative purposes, distributed approaches could equally well be used).

4. Downlink Macro Diversity

Downlink macro diversity may take different forms, depending on the service type (unicast or broadcast/multicast) and the cell structure.

For broadcast (MBMS) services, soft combining of signals transmitted from multiple cells can give a significant performance benefit. A central node (e.g. RNC) distributes the same signal to the Node Bs controlling the cells covering the desired broadcast area. Clearly, it is beneficial if broadcast transmissions in the cells use the same scrambling sequence and are time aligned within the cyclic prefix as the OFDM receiver in this case can exploit the benefits without additional processing.

For unicast transmissions, downlink macro diversity through fast cell selection has been proposed by several companies. In such schemes, the UE provides measurements to the network and, based on this reports, the network transmits unicast data from *one* of the cells in the active set. In conjunction with fast cell selection, it is beneficial to distinguish between intra-Node B and inter-Node B scenarios. In an intra-Node B scenario, all involved cells are controlled by the same Node B, while in the inter-Node B scenario, two or more Node Bs are involved. This leads to significant differences on the switching rate:

- Intra-Node B cell selection is straightforward as the same scheduler can handle all the involved cells and in principle the cell selection mechanism can operate on a TTI basis, thus exploiting variations in the instantaneous channel quality.
- Inter-Node B cell selection involves multiple Node Bs and cannot be as fast as there is a need to move the scheduling responsibility to a new Node B. The situation thus resembles hard handover for mobility reasons and the decision to switch cell is based on the long-term average channel quality.

Note that a Node B is a *logical* node and may or may not correspond to a three-sector site as illustrated in Figure 3. Hence, fast cell selection is *not* constrained to sector selection in a three-sector site only.

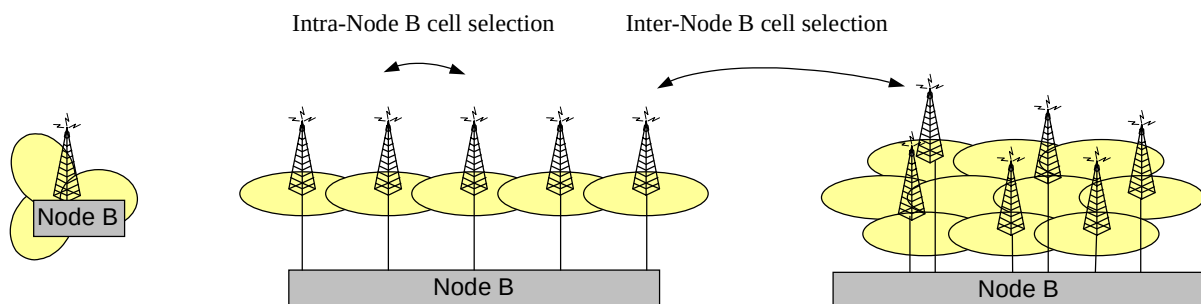


Figure 3: Examples of different deployments.

As an alternative or complement to fast intra-Node B cell selection, downlink intra-Node B soft combining has been proposed [5]. With downlink intra-Node B soft combining, the same signal is simultaneously transmitted to a single UE from multiple cells controlled by the same Node B. The benefit of soft combining is that the overall transmit power used for transmission to a single UE can be increased, leading to an improved link budget and thus the possibility for higher downlink data rates for UEs at the cell border.

At least two different approaches to downlink soft combining can be envisioned:

- **Alternative 1 (implementation approach):** In addition to the same data transmission, identical UE-specific reference signals are transmitted from each of the involved cells. In this case, multi-cell transmission will look exactly as a transmission from a single cell using a dynamic beam [6]. Thus, under the assumption that E-UTRA should anyway support adaptive beam forming, no additional specification is needed to support downlink multi-cell transmission. As the reference signal in the resulting beam only is present when data is transmitted, the Node B has to derive an estimate of the channel quality in the composite beam based on the CQI reports for each individual cell. In this alternative, soft combining of the transmission is obtained “for free”, similarly to the case for MBMS
- **Alternative 2 (specification approach):** The UE relies on the (static) cell-specific reference signals for channel estimation [6]. In this case, the UE need to perform channel estimation and demodulation individually for each cell, followed by soft combining in the UE. Hence, additional specifications are needed.

Assuming that adaptive beam forming is to be supported by E-UTRA, alternative 1 is implicitly supported. Hence, the study item should therefore investigate whether there are sufficiently large performance gains with alternative 2 to motivate the additional specification and UE implementation effort.

Conclusion: For broadcast/multicast services, it should be possible to transmit identical (time-aligned) signals from multiple cells to support soft combining. For unicast services, fast intra-Node B cell selection should be supported. Assuming support for adaptive beam forming, unicast soft combining is implicitly supported. Further studies are needed to investigate whether explicit support of unicast soft combining is required.

5. Conclusion

Based on the above discussion, the following conclusions are made:

- Cell-specific scrambling and cell-specific interleaving have similar characteristics regarding interference whitening and cell-specific scrambling is recommended due to its simpler implementation.
- Fractional reuse can increase the performance for cell-edge users. It is recommended to support fractional reuse as part of the scheduler operation.
- For broadcast/multicast services, it should be possible to transmit identical (time-aligned) signals from multiple cells to support soft combining.
- For unicast services, fast intra-Node B cell selection should be supported. Assuming support for adaptive beam forming, unicast soft combining is implicitly supported. Further studies are needed to investigate whether explicit support of unicast soft combining is required.

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EXHIBIT 1027

A Novel Inter-Cell Interference Coordination Scheme for Relay Enhanced Cellular Networks

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Abstract—Considering the latest development after introducing Relay Nodes (RNs) into the cellular networks and the effect of inter-cell interference coordination in the cellular networks, we propose a novel method of inter-cell interference coordination for relay enhanced cellular networks. Firstly, for each cell, all available frequency resource is divided into two parts. The first part is for the users connected to the BS directly, and the other part is allocated to the users connected indirectly to the BS through Relay Nodes. Furthermore, the second part of frequency resource is divided into three parts which are utilized by cell-edge users. System-level simulation results show that the proposed scheme performs better on system capacity and spectrum efficiency than the Soft Frequency Reuse (SFR) scheme.

Keywords—Relay Nodes; cellular network; inter-cell interference coordination; frequency resource; system capacity; spectrum efficiency

I. INTRODUCTION

Because of the increasing number of mobile subscribers and the growing number of mobile applications, the demands towards improving coverage and the performance of cell-edge users increase. Recently, lots of literatures show that introducing Relay Nodes into conventional cellular networks could improve the coverage of one cell, cover the shadowing area, increase the cell throughput and improve the cell-edge users' Signal to Interference and Noise Ratio (SINR) [1] [2]. However, inter-cell interference maybe a problem in relay based cellular systems as a kind of constraint on system capacity and spectrum efficiency, especially for users at the border of the cells. Therefore, it is essential and necessary to develop an efficient inter-cell interference coordination scheme for Relay Enhanced Cells (RECs) in order to improve the system capacity and spectrum efficiency.

Lots of researches and literatures mainly focus on exploring inter-cell interference mitigation schemes for conventional cellular networks. As a promising approach of the main inter-cell interference mitigation techniques, the interference coordination scheme applies restrictions to the frequency resource management in order to mitigate interference and achieve the optimal performance of the whole network [3]. Furthermore, the SFR scheme is the essential principle for the interference coordination schemes [4]. The main feature of

SFR is dividing the whole frequency resource into two parts, and one part is for cell-center users, and the other part is reserved for cell-edge users with a higher frequency reuse factor. The frequency resource for cell-edge users between adjacent cells is orthogonal, so that inter-cell interference could be mitigated to some extent [5]. A lot of researches and existing schemes are based on the principle of SFR. A dynamic score based scheduling strategy that concerns system throughput and fairness is proposed in [3]. In [6], a modified SFR (MSFR) scheme is proposed. Three frequency reuse schemes with frequency reuse factor of 1 are proposed in [7]. A dynamic inter-cell interference coordination scheme using Hungarian algorithm is described in [8].

Although many researches and schemes focus on inter-cell interference coordination, there are not too many literatures concerning how to mitigate the interference in Relay Enhanced Cells [9]. In order to make a further research on inter-cell interference in RECs, we propose a novel frequency resource allocation scheme for relay based cellular networks. First, the whole frequency resource is divided into two parts: one part is named as major part utilized by cell-center users, and the other part is named as minor part used by cell-edge users. And the frequency resource for cell-edge users between adjacent cells is orthogonal. Furthermore, the minor part of frequency resource is divided into three parts named as minor part subset 1, subset 2 and subset 3. The relay cell-center users could utilize all the minor part of frequency resource. The "relay cell" above refers to the area that a relay covers, distinct from a common cell. The relay cell-edge users could use one of the minor part subset 1, subset 2 or subset 3. In this way, the inter-cell interference is mitigated to some extent. The system capacity and the spectrum efficiency are improved dramatically. In the following system-level simulation, we take the existing SFR scheme as the benchmark. The simulation results show that the strategy proposed in the paper outperforms the SFR scheme remarkably.

The paper continues with Section II where we briefly introduce the system model of the REC network. The proposed scheme and interference analysis are described in Section III. The following Section IV provides simulation environment,

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simulation results and analysis in comparison with the SFR scheme. Finally, Section V summarizes our work.

II. RELAY-ENABLED SYSTEM MODEL

A. Relay Enhanced Cell Model

In this paper, we consider the downlink of two-hop fixed relay based cellular network with Orthogonal Frequency Division Multiplexing Access (OFDMA) physical-layer. There are 6 position fixed RNs deployed symmetrically around the cell center at the position of $2/3$ of the cell radius in each cell, as illustrated in Fig. 1. Additional RNs can be added if needed. All BSs are deployed in the cell center. The radius of the cell is R , and the distance from the cell center to the RN equals R_f . All the RNs are equipped with directional antennas. The BS communicates with a MS directly or indirectly through a relay, which depends on a routing algorithm, e.g. SINR-based routing algorithm.

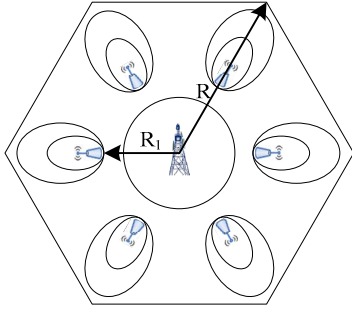


Figure 1. Basic model of relay enhanced cellular network

B. Calculations of Basic Parameters

In the following system level simulation, some equations and parameters are needed. The power of transmission node is denoted by P_t . The received signal power P_r is

$$P_r = G_{ij} \cdot P_t \quad (1)$$

where G_{ij} is the signal attenuation from the transmission node i to the receiving node j .

The propagation environment between BS, RN and MS is different, so three different pathloss equations are considered throughout the paper. The value of pathloss can be calculated by

Distance-dependent path loss for BS to MS:

$$L_{BM} = 128.1 + 37.6 \lg(R), R \text{ in kilometers} \quad (2)$$

Distance-dependent path loss for BS to RN:

$$L_{BR} = 124.5 + 37.6 \lg(R), R \text{ in kilometers} \quad (3)$$

Distance-dependent path loss for RN to MS:

$$L_{RM} = 140.7 + 36.7 \lg(R), R \text{ in kilometers} \quad (4)$$

where L is the average pathloss, and R is the distance between the transmitter and the receiver.

In this paper, the value of $SINR$ can be calculated by

$$SINR = \frac{G_{ij} \cdot P_t}{I_{intra} + I_{inter} + P_{noise}} \quad (5)$$

where I_{intra} is the intra-cell interference, I_{inter} is the inter-cell interference, and P_{noise} is the Additive White Gaussian Noise(AWGN).

The throughput of the system, denoted by T , can be calculated by

$$T = B \cdot \log_2(1 + SINR) \quad (6)$$

where B is the frequency bandwidth.

III. INTERFERENCE COORDINATION SCHEMES AND INTERFERENCE ANALYSIS

A. The Novel Frequency Resource Partitioning

The total available frequency resource is divided into N sub-channels which are orthogonal between each other. The group of $2/3$ of the total sub-channels is named as major part just as described in Section 1, and the major part is allocated to cell-center users. The group of the rest of the sub-channels is named as minor part, which is utilized by cell-edge users. Furthermore, the frequency resource for cell-edge users between adjacent cells is orthogonal. The minor part is needed to be divided into three parts again named as minor part subset 1, subset 2 and subset 3. And all the minor part of the frequency resource can be utilized by the relay cell-center users. However, the relay cell-edge users can only use one of minor part subset 1, subset 2 or subset 3. A specific scheme of frequency resource partitioning is illustrated in Fig. 2 and Fig. 3.

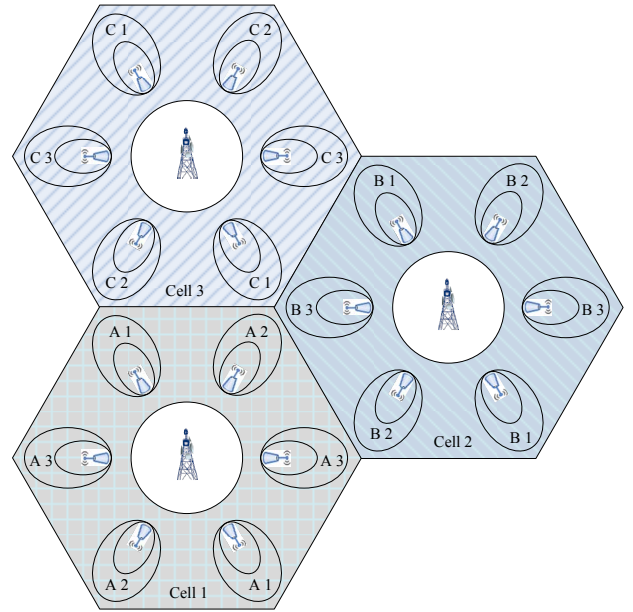


Figure 2. The novel frequency reuse scheme

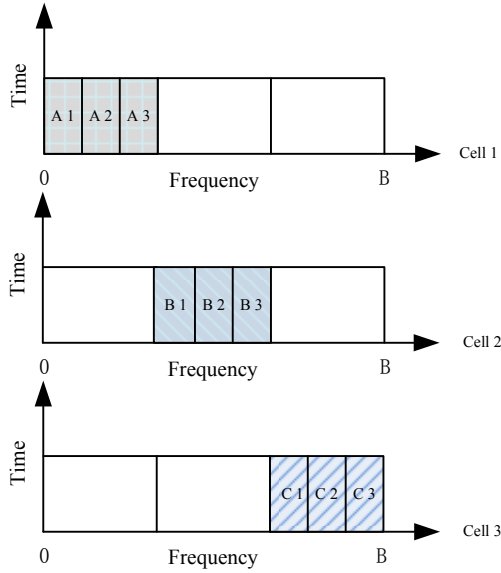


Figure 3. The frequency allocation scheme for each cell

As illustrated in Fig. 2, the shaded parts of the cells represent the edge of the cells, named as outer zone, which use the minor part of the frequency resource. The circular area of each cell represents the center of the cells, named as inner zone, which utilizes the major part of the frequency resource. For each cell, the corresponding frequency allocation scheme is illustrated in Fig. 3. For example, in the first graph of Fig. 3, the shaded parts, such as A1, A2 and A3, represent the frequency resource used by the outer zone of Cell 1 and the rest of the resource is allocated to the cell-center users in the inner zone of Cell 1. In the center of every relay cell of Cell 1, the total shaded parts, i.e. any of A1, A2 or A3, can be used. However, on the edge of any relay cell of Cell 1, only one of A1, A2, or A3 can be utilized and the three parts are deployed in rotation, as illustrated in Fig. 2. The frequency allocation scheme in other cells is similar to Cell 1. As is shown in Fig. 3, the shaded parts of the three graphs are not overlapped, so that the frequency resource for cell-edge users between adjacent cells is orthogonal.

B. Scheduling Scheme and Interference Analysis

In this paper, the BS classifies all the users into cell-center users and cell-edge users. The classification principle is as follows: if the distance from the user to the center of the cell is greater than a threshold G_{SNR} , the user is marked as cell-edge user, otherwise it is marked as cell-center user. The threshold G_{SNR} can be modified adaptively with respect to the specific circumstances. And G_{SNR} is set to be $2/3 R$ where R is the radius of the cell.

One of six available RNs can be selected for cell-edge users. The problem of the relay selection is a hot topic, which is beyond the scope of this paper. In order to simplify implementation, the principle of the relay selection is based on minimum distance which means that the RN closest to the cell-edge user will be selected as the server for the user. And other

criteria such as maximum receiving power and minimum path loss can also be used in the scheme.

First, the cell-center user is considered. We assume the user, denoted by the phone in Fig. 4, is served by the BS using the major part of the frequency resource. However, the interference analysis of the cell-center user in this scheme is different from the SFR scheme. As illustrated in Fig. 4, the cell-center user may be interfered by two neighboring BSs and four surrounding RNs in the novel scheme, while the cell-center user is interfered by two neighboring BSs in the SFR scheme.

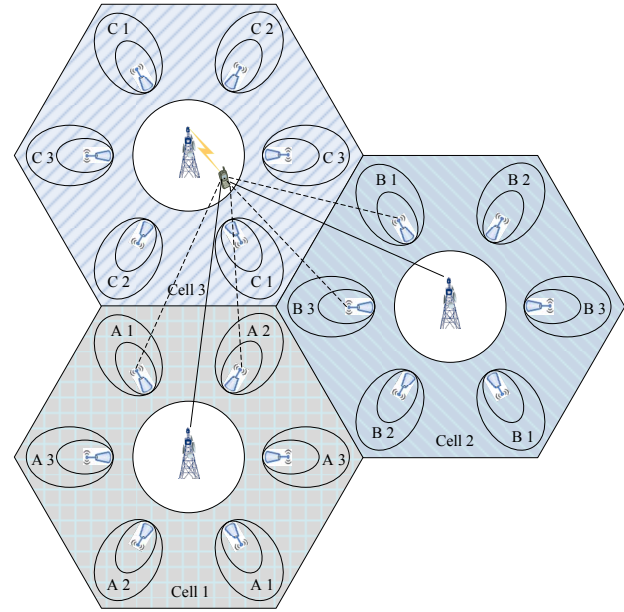


Figure 4. Interference analysis of the cell-center user

The $SINR$ of the cell-center user can be calculated by

$$\begin{aligned}
 SINR_{cell-center} &= \frac{P_{BS} / L_{BM}(R_{BM})}{\sum_{b=1}^2 \sum_{r=0}^6 (P_{RN} / L_{RM}(R_{br})) + \sum_{b=1}^2 (P_{BS} / L_{BM}(R_{b0}))} \\
 &= \frac{L_{BM}^{-1}(R_{BM})}{(L_{RM}^{-1}(R_{11}) + L_{RM}^{-1}(R_{12}) + L_{RM}^{-1}(R_{21}) + L_{RM}^{-1}(R_{23})) P_{RN} / P_{BS} + \sum_{b=1}^2 L_{BM}^{-1}(R_{b0})}
 \end{aligned} \quad (7)$$

where P_{BS} is the transmission power of BS, P_{RN} is the transmission power of RN, R_{BM} is the distance from the server BS to the considered user, R_{br} is the distance from the main interference sources to the considered cell-center user, b represents the number of the cells, r is the number of the main interference sources in the cells. For the r , it represents the BS when r is 0, and represents the corresponding RN when r is 1 to 6. In fact, the number of the main interference sources considered in (7) is a maximum case. When the cell-center user utilizes one sub-channel of the major part, the main interference sources are one interference BS and two interference RNs. In general, the transmission power of the RN is much less than the BS. The number of the interference BSs which are the main interference sources in the SFR scheme is twice of that in the novel scheme.

Second, the interference case of the cell-edge user is shown in Fig. 5. We assume the user, denoted by the phone in Fig. 5, is served by the RN using the frequency band A2. However, the interference analysis of the cell-edge user in this scheme is different from the SFR scheme. As illustrated in Fig. 5, the cell-edge user is interfered by two neighboring BSs and three surrounding RNs in the novel scheme, while the cell-edge user is interfered by two neighboring BSs in the SFR scheme. Although there are three more interference RNs in the proposed scheme than the SFR scheme, the capacity of the cell and spectrum efficiency in the novel scheme can be increased dramatically.

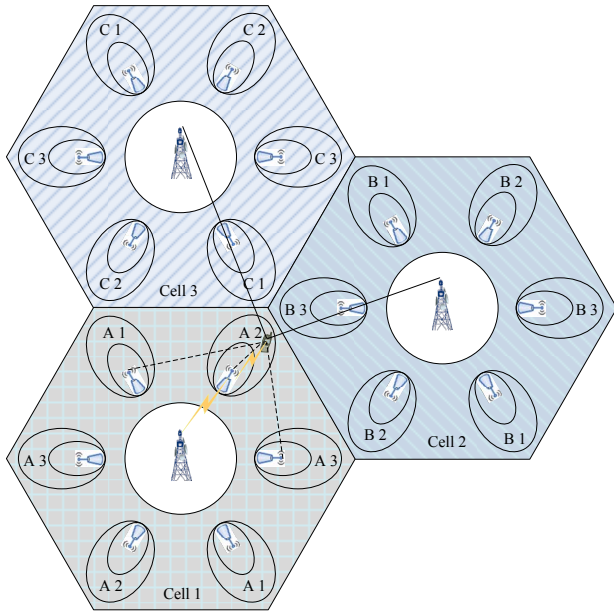


Figure 5. Interference analysis of the cell-edge user

The SINR of the cell-edge user can be expressed by

$$SINR_{cell-edge} = \frac{P_{RN} / L_{RM}(R_{RM})}{\sum_{r=1}^3 (P_{RN} / L_{RM}(R_{1r})) + \sum_{b=2}^3 (P_{BS} / L_{BM}(R_{b0}))} \quad (8)$$

where R_{RM} is the distance from the server RN to the considered user and the other parameters of (8) have the same meanings as those in (7).

IV. SIMULATION RESULTS

In this section, the performance of the proposed inter-cell interference coordination scheme is evaluated by the system level simulation. We adopt the snapshot and time-driven method in the simulation platform. In this simulation, the channel undergoes fast fading according to the motion of the MS during each “drop”. At the beginning of each “drop”, the locations of the MSs are randomly varied. The Spatial Channel Model (SCM) and log normal distribution are used as the model of fast fading and slow fading respectively [10]. The main simulation parameters are shown in Table 1.

TABLE I. THE MAIN SIMULATION PARAMETERS

Parameter	Values
Carrier frequency	2GHz
System bandwidth	10MHz
Inter-site distance	1732m
Standard deviation of slow fading	8 dB
Number of antennas	2×2
BS total transmission power	12 W
RN total transmission power	8 W
Traffic model	Full buffer
Link Adaptation	Perfect
Thermal noise power spectral density	-174 dBm/Hz
Scheduling algorithm	Proportional fair
MS speed	3 Km/h
Channel estimation	Ideal
HARQ scheme	Chase combine

In the system level simulation, the system is full load. In the proposed scheme, the MS transceivers and the BS transceivers are equipped with omnidirectional antennas, while the RN transceivers are equipped with directional antennas. And all transceivers in the SFR scheme are equipped with omnidirectional antennas [11].

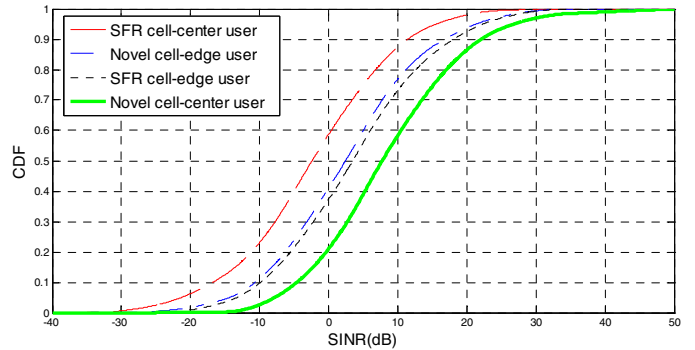


Figure 6. CDF of SINR received by cell-center user and cell-edge user

The Cumulative Distribution Function (CDF) of SINR received by cell-center user and cell-edge user is shown in Fig 6. As can be observed that the cell-center user in the novel scheme has the best SINR condition because the interference RN has less transmission power than the interference BS, moreover, there are fewest interference BSs for the cell-center user in the novel scheme. Fig 6 shows that the cell-edge user in the novel scheme has only a little SINR performance degradation compared with the cell-edge user in the SFR scheme, but has a better SINR condition than the cell-center user in the SFR scheme.

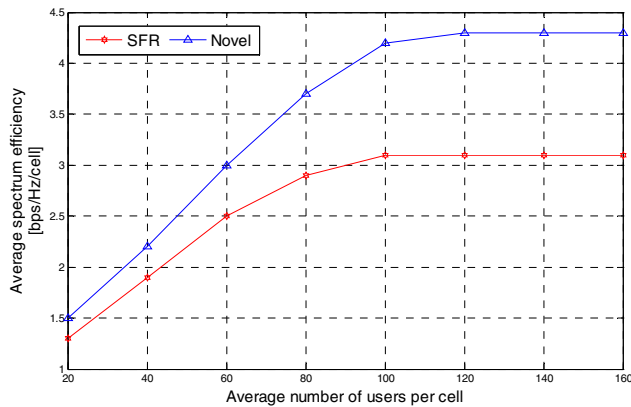


Figure 7. Average spectrum efficiency vs. MS number per cell

Fig. 7 shows the average spectrum efficiency under different MS numbers in a cell. As can be observed, the novel inter-cell interference coordination scheme has higher spectrum efficiency than the SFR scheme. It can be concluded through Fig. 6 and Fig. 7 that the novel scheme has gotten better spectrum efficiency and larger system capacity with a little SINR degradation of the cell-edge user in the proposed scheme. And the average spectrum efficiency of both schemes increases when the MS number per cell increases. Fig. 7 shows that when the number of MS in a cell increases, the proposed inter-cell interference coordination scheme has an increasing performance gain than the SFR scheme.

V. CONCLUSIONS

A novel inter-cell interference coordination scheme for relay enhanced cellular networks is proposed in this paper. The content of the novel scheme is specifically described in Section III. As can be observed in the system level simulation, the performance of the proposed novel scheme is better than the SFR scheme in terms of the average spectrum efficiency, the SINR conditions of the cell-center users and the system capacity. In a word, the novel inter-cell interference coordination scheme has obvious superior performance compared with the SFR scheme.

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 710 2 Vehicular Technology Society.
 710 2 Institute of Electrical and Electronics Engineers.
 710 2 IEEE Vehicular Technology Group.
 776 08 \$i Online version: \$t IEEE transactions on vehicular technology (Online) \$x 1939-9359 \$w (DLC) 2007213708 \$w (OCoLC)44617239
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245 00 2011 IEEE Vehicular Technology Conference.

260 Piscataway : \$b IEEE \$c Jan. 2011.

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Attachment 3a

Source: Convenor
Title: Draft Agenda
Document for: Decision

1 Opening of the meeting (Day 1: 9.00 AM)

1.1 Call for IPR

The attention of the members of this Technical Specification Group is drawn to the fact **that 3GPP Individual Members have the obligation** under the IPR Policies of their respective Organizational Partners to **inform their respective Organizational Partners of Essential IPRs they become aware of.**

The members take note that they are hereby invited:

- to investigate in their company whether their company does own IPRs which are, or are likely to become Essential in respect of the work of the Technical Specification Group.
- to notify the Director-General, or the Chairman of their **respective** Organizational Partners, of all potential IPRs that their company may own, by means of the IPR Statement and the Licensing declaration forms (e.g. see the ETSI IPR forms <http://webapp.etsi.org/Ipr/>).

2 Approval of the agenda

3 Approval of the minutes from the previous meetings

4 Election of the RAN1 Chairman and Vice-Chairmen

For candidatures received see: http://www.3gpp.org/tb/RAN/RAN1/elections2005/RAN1_election.htm

5 Liaison statement handling

6 Maintenance of R99, Rel4, Rel5, Rel6

6.1 R99 CRs + shadow CRs

6.2 Rel4 CRs + shadow CRs

6.3 Rel5 CRs + shadow CRs

6.4 Rel6 CRs

6.5 Other

7 1.28 Mcps TDD Channelisation Code Optimisation

8 3.84 Mcps TDD Enhanced Uplink

9 7.68 Mcps TDD Option

10 Evolved UTRA and UTRAN (Physical Layer) (Day 2 – 4)

10.1 Uplink Macro-Diversity ($\approx \frac{1}{2}$ day)

10.2 Inter-cell Interference Mitigation/Coordination ($\approx \frac{1}{2}$ day)

10.2.1 Downlink

10.2.2 Uplink

10.3 Further discussion on SC-FDMA/OFDMA for FDD Uplink ($\approx \frac{1}{2}$ day)

(Continue discussion of some of the bigger aspects of the proposals, e.g. PAPR)

10.4 Further aspects of OFDMA for FDD Downlink ($\approx \frac{1}{2}$ day)

10.5 MIMO schemes ($\approx \frac{1}{2}$ day)

10.5.1 General

10.5.2 Downlink

10.5.3 Uplink

10.6 TDD specific aspects ($\approx \frac{1}{2}$ day)

10.7 LTE Topics for discussion depending on available meeting time

10.7.1 Initial simulation results

10.7.2 Further text proposals for the TR

10.7.3 Other topics

11 Multiple Input Multiple Output Antennas (Rel'7 MIMO work item)

Day 3, probably in connection with the LTE MIMO discussion.

12 Improved Support of IMS Realtime Services using HSDPA/HSUPA (Day 5)

13 Continuous Connectivity for Packet Data Users (Day 5)

14 Closing of the meeting (Day5: 5.00 PM)

Attachment 4a

Source: Convenor
Title: Draft Agenda
Document for: Decision

1 Opening of the meeting (Day 1: 9.00 AM)

1.1 Call for IPR

The attention of the members of this Technical Specification Group is drawn to the fact **that 3GPP Individual Members have the obligation** under the IPR Policies of their respective Organizational Partners to **inform their respective Organizational Partners of Essential IPRs they become aware of.**

The members take note that they are hereby invited:

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- to notify the Director-General, or the Chairman of their **respective** Organizational Partners, of all potential IPRs that their company may own, by means of the IPR Statement and the Licensing declaration forms (e.g. see the ETSI IPR forms <http://webapp.etsi.org/Ipr/>).

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6.1 R99 CRs + shadow CRs

6.2 Rel4 CRs + shadow CRs

6.3 Rel5 CRs + shadow CRs

6.4 Rel6 CRs

6.5 Other

7 1.28 Mcps TDD Channelisation Code Optimisation

8 3.84 Mcps TDD Enhanced Uplink

9 7.68 Mcps TDD Option

10 Evolved UTRA and UTRAN (Physical Layer) (Day 2 – 4)

10.1 Uplink Macro-Diversity ($\approx \frac{1}{2}$ day)

10.2 Inter-cell Interference Mitigation/Coordination ($\approx \frac{1}{2}$ day)

10.2.1 Downlink

10.2.2 Uplink

10.3 Further discussion on SC-FDMA/OFDMA for FDD Uplink ($\approx \frac{1}{2}$ day)

(Continue discussion of some of the bigger aspects of the proposals, e.g. PAPR)

10.4 Further aspects of OFDMA for FDD Downlink ($\approx \frac{1}{2}$ day)

10.5 MIMO schemes ($\approx \frac{1}{2}$ day)

10.5.1 General

10.5.2 Downlink

10.5.3 Uplink

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Day 3, probably in connection with the LTE MIMO discussion.

12 Improved Support of IMS Realtime Services using HSDPA/HSUPA (Day 5)

13 Continuous Connectivity for Packet Data Users (Day 5)

14 Closing of the meeting (Day5: 5.00 PM)

Attachment A

CURRICULUM VITAE SYLVIA D. HALL-ELLIS

EDUCATION

Ph.D., University of Pittsburgh, Pittsburgh, Pennsylvania, 1985
 M.P.S., University of Denver, Denver, Colorado, 2014
 Post Graduate Studies, University of Texas – San Antonio, Texas, 1975-1976
 M.L.S., University of North Texas, Denton, Texas, 1972 B.A.,
 Rockford University, Rockford, Illinois, 1971

PROFESSIONAL EXPERIENCE

- 1981-** **Consultant for higher education, non-profit organizations, and corporations.**
- 2002-** **Adjunct Professor, School of Information, San José State University, San José, California.** Serve as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), “core courses,” and special topics.
- 2014-2016** **Director, Grants and Resource Development, Colorado Community College System.**
 Provided leadership and vision to foster the continued growth of rigorous scholarship, innovative projects, and creative work for statewide system, 13 campuses, and 50 teaching sites serving 155,000 students. Responsible for leadership and ensured efficient functioning of contract and grants in compliance with state & federal requirements and successful implementation and management. Served as a subject matter expert and liaison for college Grant Directors for all issues relating to grants and subcontracts.
- 2010-2014** **Senior Grant Administrator, Morgridge College of Education, University of Denver (Colorado).** Provided leadership and vision to foster continued growth of rigorous scholarship, innovative research, and creative work in the Morgridge College of Education. Ensure that contract and grants processes function effectively and efficiently for 60 faculty and researchers with a focus on the successful progression and efficient management of grants totaling \$13M. Worked effectively and collegially with Department Chairs and Program Coordinators on operational grant-related management activities and with a broad range of internal and external constituencies. Supported the dissemination and promotion of faculty research and scholarship to outside constituents at conferences and through publications. Assisted Principal Investigators and grant project teams by coaching, mentoring, and financial management.
- 2011-2013** **Interim Director & Assistant Dean, Westminster Law Library, Sturm College of Law, University of Denver.** Planned, organized, and directed all administrative activities for the library serving students, faculty, and alumni; oversaw the employment, retention, promotion, transfer and termination of library personnel; represented the library at professional conferences and public meetings; created and promoted a climate and culture of acceptance for new programs and services, a positive high-quality image of the law library, and that reflect the organization’s values, encourage excellent performance, and reward high productivity and innovation; provided leadership and set strategic direction of the organization; ensured that the library provided excellent customer service through solution-oriented staff response to patron needs and by responsiveness and continuous improvement of the organization; promoted, developed, and maintained positive working relationships with colleagues and customers including key stakeholders and groups, higher education institutions, the legal community, other regional libraries and districts statewide, and national library organizations.
- 2007-2014** **Associate Professor, Library & Information Science, Morgridge College of Education, University of Denver (Colorado).** Served in leadership role and worked collaboratively in

program, college, campus and community environments. Advised and supervised students, taught core and specialized courses at the graduate level in an integrative, student-centered learning environment. Served on LIS, College, and University committees, and maintained working relationships with colleagues in other academic units and information professionals in the Rocky Mountain region and beyond. Served on and chair doctoral student dissertation committees. Oversaw and facilitated the College and LIS graduate student association.

- 2002-2007** **Assistant Professor, Library & Information Science, College of Education, University of Denver (Colorado).** Served as tenure-track faculty member teaching graduate students in “core courses,” resource description and access, service learning, and independent studies. Advised graduate students, participate on LIS and College committees, and serve on doctoral student dissertation committees. Oversaw and facilitated the LIS graduate student association and alumni association.
- 2000-2002** **Affiliate Faculty, Library & Information Science, College of Education, University of Denver (Colorado).** Served as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), “core courses,” and special topics. Oversaw and facilitated the LIS graduate student association and alumni association.
- 2000-2001** **Special Assistant to the Secretary’s Regional Representative, U.S. Department of Education, Region VIII, Denver, Colorado.** Served as the principal advisor and representative of the U. S. Secretary of Education’s Regional Representative (SRR). Ensured the implementation of major goals of the SRR and the Secretary. Provided leadership on behalf of the SRR in contacts with high-level officials in Region VIII requiring sensitive policy interpretation in communication with senior Department officials to solve problems and resolve issues raised by State and local education officials. Served as the primary contact for School-to-Work/Career, Children’s Health Insurance Program, and Safe and Drug-Free Schools. Delivered technical assistance to local education agencies and institutions of higher education in technology, professional development, and school construction.
- 1999-2000** **Catalog Librarian, Jefferson County Public Library, Lakewood, Colorado.** Performed original, copy cataloging and classification of library materials (English and Spanish) using standard library protocols; completed original descriptive cataloging and subject analysis; enhanced brief catalog and authority records in III.
- 1997-1999** **Development Officer, McREL International, Aurora, Colorado.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for educational agencies. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.
- 1995-1997** **Education Specialist, Education Service Center, Region One, Edinburg, Texas.** Served as member of Administrative Cabinet team in strategic planning, development of proposals and contracts, implementation, and evaluation of telecommunications capabilities, services, products, and programs for 40 school districts serving 283,000 students in 7 counties. Provided creative leadership to regional and state committees to solicit ideas, identify strategic goals and objectives, plan, develop, present, and evaluate funding opportunities and professional development for 400 librarians.
- 1993-1996** **Assistant Professor of Library Science, Sam Houston State University, Huntsville, Texas.** Served a faculty member teaching 400 graduate students in technical services (cataloging,

bibliographic control, classification), automation, and networking. Participated in distance education program and coordinated annual conference. Conducted university and Texas Library Association-funded field research focused on library collection development and academic achievement.

- 1992-1993** **Head Librarian, Rocky Mountain College of Art & Design, Denver, Colorado.** Responsible for the daily operation, selection and acquisition of materials, formulation of policies for library operations, media center, and photography/slides archives. Designed and implemented library automation and delivery of electronic resources to college community.
- 1981-1985** **Development Officer, PRLC, Inc., Pittsburgh, Pennsylvania.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for 100 institutional member organizations. Coordinated the development of proposals and contracts totaling \$4,000,000 annually. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.
- 1981** **Director of Library Development, Pennsylvania Department of Education, Harrisburg, Pennsylvania.** Responsible for statewide development, technical assistance, professional development, resource sharing, children's services, institutional library services, networking, and state aid program for all libraries throughout the Commonwealth. Functioned as liaison to Governor's Advisory Council, LSCA Advisory Council, District Administrators, private colleges, universities, consortia managers, and network directors. Supervised \$14,000,000 formula-based state aid program and \$3,000,000 grant awards to individual libraries, consortia, and networks.
- 1978-1981** **Assistant Director, Southern Tier Library System, Corning, New York.** Coordinated operation of system-wide programs (technical assistance, professional development, resource sharing, technical services, outreach) to 40 public libraries in 5 counties serving 500,000 residents. Solicited ideas, identified goals, sponsored, and evaluated professional development opportunities and technical assistance sessions.
- 1976-1978** **Division Librarian for Technical Services, Corpus Christi Public Libraries, Corpus Christi, Texas.** Provided leadership in acquisitions, cataloging, serials control, and processing for main library and 4 branches serving 250,000 residents. Participated as senior member of library management team. Compiled and prepared technical evaluations, reports, and statistical analyses of Division operations to measure the achievement and cost of annual goals, objectives, and staff performance.
- 1975-1976** **System Coordinator, San Antonio Major Resource Center, San Antonio, Texas.** Served as senior member of the management team for District X Office, charged to provide technical assistance, resource sharing, media services, and professional development to librarians and staff representing 30 public library jurisdictions in 21 counties serving 1,500,000 residents. Functioned as liaison to System Director, staff, and members of governing bodies with the System Board of Directors and the Texas State Library and Historical Commission. Prepared LSCA grant applications and monitored awards totaling \$1,100,000 annually.
- 1973-1975** **Bilingual Branch Librarian, San Antonio Public Library, San Antonio, Texas.** Worked as librarian providing reference, information, and readers' advisory services in branch serving 50,000 Spanish-speaking residents in southwest San Antonio. Participated in collection development and resource acquisition activities, specializing in children's work, Spanish language resources, and multicultural studies.

- 1972-1973** **Librarian, Holding Institute, Laredo, Texas.** Worked as high school librarian serving 500 boarding students in Spanish-speaking environment of private school. Provided reference, research assistance, and library instruction to students and 35 faculty members.
- 1966-1971** **Rockford Public Library, Rockford, Illinois.** Worked in branches as part-time as a Library Assistant, Clerk, and Page in city library serving 150,000 residents.

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- Hall-Ellis, Sylvia D. *Denver Public Library: Opportunities for Change*. Denver, Colo.: University of Denver, Colorado Community-Based Research Network & Metropolitan Organization of People, 2005.
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- Gómez-Jurado, Juan. *A Masacre de Virginia Tech: Anatomía de una Mente Torturada*. Barcelona: Ediciones El Andén, 2007. 978-84-935789-4-7, €16.50 [*Críticas*, February, 2008]
- Matthews, Joseph R. *Library Assessment in Higher Education*. Westport, Conn.: Libraries Unlimited, 2007. 978-1-59158-531-2, \$45.00 [*Colorado Libraries*, February 2008]
- Chacón, Inma. *La Princesa India: Cuando el Viento Azul*. México: Alfaguara, 2006. 970-770398-9, \$19.95 [*Críticas*, June 2006]
- Vargas Llosa, Mario. *Israel/Palestina: Paz o Guerra Santa*. fotogs. by Morgana Vargas Llosa. Spain/U.S.: Aguilar: Santillana, 2006. 84-03-09691-7, paper, \$19.95 [*Críticas*, May 2006]
- Findlay, Diane. *Digging into Dewey*. Fort Atkinson, Wisc.: Upstart Books, 2005. 978-1-932146-18-9, \$16.95 [*Colorado Libraries*, May 2006]
- Pequeñas Resistencias 4: Antología del Nuevo Cuento Norteamericano y Caribeño*. Menéndez, Ronaldo, Ignacio Padilla & Enrique del Risco, eds. Madrid: Páginas de Espuma, 2005. 84-95642-59-X, paper, \$36.95 [*Críticas*, April 2006]
- Rueda, André. *Vengo a Salvar a España: Biografía de Un Franco Desconocido*. Madrid: Nowtilus (Investigación Abierta), 2005. photogs., bibliog. 84-9763-202-8, paper, \$23.95 [*Críticas*, March 2006]
- Becerra, Ángela. *El Penúltimo Sueño*. 1st ed. Barcelona: Planeta, 2005. 84-08-05795-2, \$25.95. [*Críticas*, January 2006]
- Aguilar Camín, Héctor. *La Conspiración de la Fortuna*. 1st ed. México: Planeta, 2005. 970-37-0368-2, \$19.95 [*Críticas*, October 2005]
- México en Sus Libros*. Enrique Florescano with Pablo Mijangos, editors & compilers. 1st ed. México, D.F.: Taurus Aguilar, 2004. 968-19-0783-3, \$16.95 [*Críticas*, September 2005]
- Historia Económica de México*. Coordinator, Enrique Semo. México: Universidad Nacional Autónoma de México, Editorial Oceano de México, 2004. 13 vols. 970-32-0805+3 (obra completa), \$9.25 each [*Críticas*, August 2005]

- Czarnowsky, Christyne A. and Michael H. Williams. *Managing Your Wired Workforce: A Practical Guide*. Denver, Colo.: Bradford Pub., 2003. 1-883726-79-4, \$24.95 [*Colorado Libraries*, 2004]
- Abraham Lincoln*. Colección Grandes Biografías. Madrid: Edimat Libros, 2003. 84-8403-858-0, €4.95 [*Críticas*, 2004]
- Alponte, Juan María. *Colón: el Hombre, el Navegante, la Leyenda*. México, D.F.: Aguilar, 2003. 968-19-1260-8, \$16.95 [*Críticas*, 2004]
- Olcese Salvatecci, Alfieri. *Cómo Estudiar con Éxito: Técnicas y Hábitos Para Aprender Mejor*. México, D.F.: Alfaomega Grupo Editor, 2002. 970-15-0764-9 [*Críticas*, 2003]
- Mujeres Como Islas: Antología de Narradoras Cubanas, Dominicanas, Puertorriqueñas*. Edición: Olga Marta Pérez, Thelma Jiménez, Andrés Blanco D., eds. Santo Domingo, República Dominicana: Ediciones Ferilibro, 2002. 959-209-419-5 [*Críticas*, 2003]
- Tibol, Raquel. *Los Murales de Diego Rivera: Universidad Autónoma Chapingo*. México, D.F.: Editorial RM, Universidad Autónoma Chapingo, 2002. 968-5208-08-5 [*Críticas*, 2003]
- Lindsay-Poland, John. *Emperors in the Jungle: the Hidden History of the U.S. in Panama*. Durham, N.C.: Duke University Press, 2003. 0-8223-3098-9, \$18.95 [*Críticas*, 2003]
- Kaplan, Allison G. and Ann Marlowe Riedling. *Catalog It! A Guide to Cataloging School Library Materials*. Worthington, Ohio: Linworth Pub., 2002. 1-58683-014-7, \$44.95 [*Colorado Libraries*, 2002]
- Bardach, Ann Louise. *Cuba Confidential: Love and Vengeance in Miami and Havana*. New York: Random, 2002. 0-375-50489-3, \$25.95 [*Library Journal*, 2002]
- Swan, James. *Fundraising for Libraries: 25 Proven Ways to Get More Money for Your Library*. New York: Neal Schuman, 2002. 1-55570-433-6, \$69.95 [*Colorado Libraries*, 2002]
- Puig de Lange, Victoria. *Sol Con Agua*. Nashville, Tenn.: Editorial Vistazo/Ediciones Reio Negro, 2002. 0-9724506-0-2, \$17.75 [*Críticas*, 2002]
- The Encyclopedia of Latin American Politics*. Edited by Diana Kapiszewski; assistant editor, Alexander Kazan. Westport, Conn.: Oryx Press, 2002. 1-57356-306-4, \$74.95 [*Library Journal*, 2002]
- Vargas Lizano, Isabel. *Y Si Quieres Saber de Mi Pasado*. Con la colaboración de J.C. Vales. Madrid: Santillana Ediciones Generales, S.L., 2002. 84-03-09278-4, \$18.95 [*Críticas*, 2002]
- Ruy Sánchez, Alberto. *Los Jardines Secretos de Mogador: Voces de Tierra*. México, D.F.: Alfaguara, S.A., 2001. 968-19-0879-1, \$16.95 [*Críticas*, 2002]
- Chávez, Ricardo and Celso Santajuliana. *El Final de las Nubes*. Barcelona: RBA Libros, S.A., 2001. 84-7901-760-0, \$11.95 [*Críticas*, 2002]
- The Power of Language / El Poder de la Palabra: Selected Papers from the Second REFORMA National Conference*. Edited by Lillian Castillo-Speed and the REFORMA National Conference Publications Committee. Englewood, Colo.: Libraries Unlimited, 2001. 1-563089459, \$35.00 [*Colorado Libraries*, 2001]
- Martínez, Rubén. *Crossing Over: A Mexican Family on the Migrant Trail*. Metropolitan: Holt, 2001. 0-8050-4908-8, \$26.00 [*Library Journal*, 2001]

Guevara, Ernesto "Che." *The African Dream: the Diaries of the Revolutionary War in the Congo*. Translated from the Spanish by Patrick Camiller. With an introduction by Richard Gott and a foreword by Aleida Guevara March. New York: Grove Press, 2001. 0-8021-3834-9, \$13.00 [*Library Journal*, 2001]

Cooper, Gail and Garry Cooper. *New Virtual Field Trips*. Englewood, Colo.: Libraries Unlimited, 2001. 1-56308-887-8, \$27.50 [*Colorado Libraries*, 2001]

NATIONAL SERVICE & PROFESSIONAL AFFILIATIONS

American Library Association, Life Member

Association for Library Collections & Technical Services (now CORE)
Cataloging, Classification, and Metadata Section
ALCTS Editorial Board, Member, 2015-2019
Committee on Cataloging: Description and Access, Member, 2008-2012
Test Site for RDA, Manager, 2009-2011
Nominating Committee, Member, 2007-2008
Committee for Education and Training of Catalogers, Chair, 2006-2007, Member, 2003-2007
Competencies & Education for a Career in Cataloging Interest Group, Chair, 2010-2012; Member, 2010-
President's Program Committee, 2015-2016
Education Committee, Member, 2005-2007
Task Force on Competencies and Education for a Career in Cataloging, Chair, 2007-2009
2007 Annual Meeting Pre-conference, "What They Don't Teach in Library School: Competencies,
Education and Employer Expectations for a Career in Cataloging," Steering Committee Chair
Fundraising Committee, Member, 2004-2006
Office of Diversity
Committee on Diversity, Chair, 2010-2011
Diversity Research Advisory Committee, Member, 2009-2010
Spectrum Scholar Mentor, 2009
Diversity Grants Review Committee, Member, 2007, 2010, 2012
Office of Statistics and Research
Research and Statistics Committee, Member, 2005-2007; Intern, 2003-2005
Library Research Round Table
Nominating Committee, 2022-2023
Membership Committee, 2019-2021
Board of Directors, Member At-Large, 2009-2012
Office of Accreditation
Accreditation Panel Member (training completed 2004)
Accreditation Review Panel Member (training completed 2004)

REFORMA, Life Member

National Board of Directors, 2005-2013
National Fundraising Chair, 2005-2013
National Recruiting and Mentoring Committee, 2008-2010
Colorado Chapter, Secretary, 2004-2005
Colorado Chapter Liaison to National Board of Directors, 2004-2013

American Association of Law Libraries (AALL), Life Member Online Audiovisual Catalogers Association (OLAC) Colorado Association of Law Librarians (CoALL)

American Association of University Women Association for Library and Information Science Education (ALISE)

University of Denver ALISE Representative, 2003-2008; 2010-2011
Membership Advisory Committee, 2007-2010
Technical Services Education Special Interest Group, 2003-
Garfield Doctoral Dissertation Award Reviewer, 2012
Garfield Doctoral Dissertation Scholarship Reviewer, 2014
American Association of University Professors (AAUP), 2006-

American Grant Writers Association, 2014- Grant Professionals Institute, 2016- National Grants Management Association, 2014-

Grant Reviewer (National and Regional Team Leader), U.S. Department of Education, 1998- Grant Reviewer, Broadband Technologies Opportunity Program, U.S. Department of Commerce, 2009
Grant Reviewer, Institute of Museum and Library Services, 1998-2000
Grant Reviewer, Colorado Department of Education, 2014-
Grant Reviewer, Colorado State Library, 1998-
Grant Reviewer, American Association of Community Colleges *Working Connections* program, 1999
Peer Reviewer, *Journal for Library and Information Science Education*, 2005-
Peer Reviewer, *Journal of Library Metadata*, 2009
Peer Reviewer, *International Journal of Library and Information Science*, 2011
Regular Columnist, *The Bottom Line*, 2013-2016
Book Reviewer, *Library Journal*, 2001
Book Reviewer, *Críticas*, 2002-2009
Book Reviewer, *Colorado Libraries*, 2000-2012

REGIONAL SERVICE & PROFESSIONAL AFFILIATIONS

Mountain Plains Library Association

Professional Development Grants Committee, Member, 2005-2006
Professional Development Policy and Guidelines Sub-committee Chair, 2006

Colorado Association of Libraries

“Student Voices” Column Editor, *Colorado Libraries*, 2005-2006
Conference Planning Committee, Member, 2002
Technical Services and Automation Division, Chair, 2002-2003; Member, 2000-
Academic Libraries Division, Peer Review Conference Papers Committee, Member, 2007-2009
Education Committee, Member, 1988-1993
Diverse Populations Committee, Member, 2009-2013

SERVICE TO THE UNIVERSITY OF DENVER

Center for Teaching and Learning Faculty Advisory Board, 2007-2008; 2010-2012
Center for Community Engagement and Service Learning Advisory Board, 2007-2012
Faculty Senate
Executive Committee, 2008-2013
Nominations, Rules & Credentials Committee, Chair, 2008-2013; Member 2007-2013
Appointment, Promotion, and Tenure Revision Committee, 2010-2012
Grievance Policy Committee Member, 2007-2010
Law Library Director Search Committee Chair, 2012-2013
PROF Grant Review, College Representative to the University Review Team, 2006, 2008
Project Homeless Connect Evaluations, Principal Investigator, 2006-2009
University Technology Council, 2007-2009
University of Denver Hyde Interviews for Incoming Freshmen, 2003-2012

SERVICE TO THE MORGRIDGE COLLEGE OF EDUCATION

Appointment, Tenure & Review Committee
Member, voting, 2003-2005; 2007- 2009
Chair, Clinical Faculty Promotion & Tenure Policy Subcommittee, 2008-2009
Member, Community Engagement Subcommittee, 2007-2009
Member, Tenure Review Panel, 2003
Advancement and Alumni Relations Committee, Chair, 2003-2007; Member, 2002-2007
College Building Committee Member, 2004-2010

College of Education Student Association, Faculty Advisor, 2004-2007; 2009-2010
Faculty Senator, 2007-2013
Research and Scholarship Committee, Chair, 2008-2009; Member, 2002-2003, 2008-2009
Research and Grant Mentoring Committee, Chair, 2009-2010
Research Task Force Member, 2010-2012
Search Committee Member, Assistant Professor for Curriculum & Instruction, 2010-2011
Workload Task Force Member, 2010-2011

SERVICE TO THE LIBRARY & INFORMATION SCIENCE PROGRAM

Library and Information Science Student and Alumni Association, Faculty Advisor, 2002-2008
ALA Student Chapter, Faculty Advisor, 2005-2008
Beta Phi Mu Phi Chapter, Faculty Advisor, 2004-2014
Steering Committee Member, Accreditation by the American Library Association, 2001-2004
Search Committee Member, Associate Professor for LIS, 2006
Search Committee Chair, Assistant Professors for LIS, 2003, 2005, 2006, 2007
Search Committee Ex-Officio Member, Director for LIS, 2004

SERVICE TO SAM HOUSTON STATE UNIVERSITY

Rio Roundup: South Texas Literature Conference, Conference Coordinator, 1993
External Relations, Fund Raising, Grants Committee, Chair, 1993-1995
Advisory Council Committee, Chair, 1993-1995
Students, Admissions, and Advisement Committee, Chair, 1994
Institutional Effectiveness Committee, Member, 1993-1995

SERVICE TO THE COLLEGE OF EDUCATION AND APPLIED SCIENCE

Faculty Affairs Committee, Member, 1993-1995
Curriculum Committee, Member, 1993-1995
Continuing Education Committee, Member, 1993-1995

SERVICE TO THE COMMUNITY

French Teacher & Student Exchange with Laon, France, Monarch High School, Boulder Valley School District
(Boulder, Colorado), 2017-
Denver/Boulder Games 2022, Board of Directors, Secretary-Treasurer, 2015-2018
United Way Campaign Committee, College of Education, 2006
Arapahoe County, Election Judge for the County Clerk and Recorder, 2000-2005
Arthritis Foundation, Rocky Mountain Chapter, Certified Educator & Trainer, 1999-2008
Bonfils Blood Center, Silver Level Donor, 2000-2016
Denver Museum of Natural History, Docent, 1992
Tech Prep of the Lower Rio Grande Valley, Inc. (Harlingen, Texas) Board of Directors, 1995-1997
Executive Committee, 1996-1997; Chair, Development Committee, 1995-1997; Chair, Fiscal Agency
Committee, 1995-1996; Chair, Colleges and Universities Committee, 1996-1997
Gilpin County (Colorado) Public Library Board of Trustees, 1986-1989; Vice President, 1987-1989
City of Central (Colorado) Economic Development Committee, 1987-1989
Columbine Family Health Centers, Inc. (Nederland and Black Hawk, Colorado) Board of Directors, 1988-1989

CERTIFICATION

Permanent Public Librarian Certificate - Pennsylvania, New York, Texas
Westlaw Expert Witness, 2008-
Certified Grant Writer®, 2016-

AWARDS AND HONORS

Advanced Practitioner for Service Learning and Community Engagement, University of Denver, 2011

Platinum Star Alumnae, College of Information, Library Science & Technologies, University of North Texas, 2009
 Commendation for Integration of Technologies in Teaching & Learning Environment, University of Denver, 2006
 Outstanding Adjunct Faculty Member Award, College of Education, University of Denver, 2002
 Beta Phi Mu, Pi, University of Pittsburgh, 1985
 Alpha Lambda Sigma, University of North Texas, 1972
Albert Nelson Marquis Lifetime Achievement Award, Who's Who in America
Who's Who in American Women
Who's Who of Women Executives
Dictionary of International Biography
Who's Who in the East
Who's Who in the South and Southwest
Who's Who in the World
Who's Who of Online Professionals
Who's Who in Library and Information Science
2,000 Notable Women
Who's Who of Emerging Leaders
Who's Who in Professional and Executive Women
Who's Who in American Education
International Who's Who of Professional and Business Women
International Leaders in Achievement
International Educator of the Year
Who's Who in Finance and Industry
Who's Who in Finance and Business

Invited International and National Conference Presentations

Driscoll, Margaret, Christy Confetti Higgins, Scott Brown, and Sylvia D. Hall-Ellis. *A View from Within: Open House Tour of Three Canvas Core Courses*. Presentation to be delivered at the School of Information, San José State University Professional Development Seminar, San José, California, October 17, 2019.

Hall-Ellis, Sylvia D. *Invest in Me -- I'm Your Future: Succession Planning for Libraries*. Keynote presentation delivered at the ALCTS President's Symposium, Boston, Mass., January 8, 2016.

Seidel, Kent E. and Sylvia D. Hall-Ellis. *Making Grants Work for You: Strategies for Doctoral Students and Early Career Scholars*. Presentation delivered at the University Council for Educational Administration, Early Career Scholars Session, Indianapolis, Ind., November 9, 2013.

Hall-Ellis, Sylvia D. *So You Want to be a Manager; Leadership Skills and Competencies for Technical Services Managers and Administrators*. Presentation delivered at the 138th Annual Conference, American Library Association, Chicago, Ill., June 29, 2013.

Seidel, Kent E., Karen S. Riley, Lyndsay Agans, Susan Korach, and Sylvia D. Hall-Ellis. *Making Grants Work for You (Instead of Just Working for Grants)*. A panel discussion delivered at the University Council for Educational Administration, Early Career Scholars Session, Denver, Colo., November 17, 2012.

Hall-Ellis, Sylvia D. *After the Great TS Reorganization: The Westminster Law Library*. Presentation delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 23, 2012.

Hall-Ellis, Sylvia D. *Conversations with Catalogers in the 21st Century*. A panel discussion sponsored by the ALCTS Competencies for a Career in Cataloging Interest Group, delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 22, 2012.

- Hall-Ellis, Sylvia D., moderator. *Mid-Career Leaders Program*. A panel discussion sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 26, 2011.
- Hall-Ellis, Sylvia D., moderator. *Diversity Town Hall*. A community conversation sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 24, 2011.
- LaBarre, Kathryn, Sylvia D. Hall-Ellis, Karen Anderson, Rick Hasenyager, Christopher Cronin, and Penny Baker. *Briefings from RDA Test Participants*. A panel discussion delivered at the Midwinter Conference, American Library Association, San Diego, Calif., January 7, 2011.
- Miksa, Shawne, Marjorie Bloss, and Sylvia D. Hall-Ellis. *Educating the Next Generation of Catalogers: Teaching RDA*. A panel discussion delivered at the 97th Annual Conference, Association for Library and Information Science Education, San Diego, Calif., January 7, 2011.
- Hall-Ellis, Sylvia D., Robert Maxwell, John Hostage, and George Prager. *RDA Panel: What Cataloging Managers Need to Know*. Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 12, 2010.
- Hall-Ellis, Sylvia D. and Stacey L. Bowers. *Catalogers in the RDA Environment: Skill Sets, Expectations and Challenges*. Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 11, 2010.
- Hall-Ellis, Sylvia D. *Comfortable in Your Cataloging and Metadata Specialist Skin? Or, So You Want to Hire a Cataloger*. Presentation delivered to the ALCTS Research Group at the 134th Annual Conference, American Library Association, Chicago, Ill., July 11, 2009.
- Perez, Megan, Sylvia D. Hall-Ellis, and Denise Anthony. *From Novice to Expert: Collaboration for Succession Planning*. A “hot topic” presentation delivered at the 14th ACRL Conference, Seattle, Wash., March 13, 2009.
- Hall-Ellis, Sylvia D. *Cataloging in the RDA Environment: Skill Sets, Expectations and Challenges*. Presentation delivered to the ALCTS Research and Publications Committee at the Midwinter Conference, American Library Association, Denver, Colo., January 24, 2009.
- Hall-Ellis, Sylvia D. *LIS Cataloging Education for the 21st Century: Expectations and Challenges*. A panel discussion held at the 95th Annual Conference, Association for Library and Information Science Education, Denver, Colo., January 23, 2009.
- Chu, Clara, Sylvia D. Hall-Ellis, and Mark Winston. *The Doctoral Degree & Building a Career*. A panel discussion delivered at the ALA Office of Diversity Spectrum Doctoral Fellows E.J. Josey Leadership Institute, Midwinter Conference, American Library Association, Denver, Colo., January 20, 2009.
- Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Fundamentals of Cataloging Course: An Overview of the ALCTS Online Course*. Presentation delivered to the ALCTS Big Heads Group, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 30, 2008.
- Hall-Ellis, Sylvia D. *Employers’ Expectations for Technical Services Librarians: What We Don’t Know*. Presentation delivered to the ALCTS Research and Publications Committee Program, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 28, 2008.

Hall-Ellis, Sylvia D., Virginia R. Maloney, and Mary Stansbury. *Institutional Responses to Engaged Scholarship: The Carnegie Foundation Engaged University Classification at Two Universities*. Presentation delivered to the 94th Annual Conference, Association for Library and Information Science Education, Philadelphia, Pa., January 11, 2008.

Hall-Ellis, Sylvia D. *Puzzles, Problems, and Predicaments*. Presentation delivered to the ALCTS Research Discussion Group, 132nd Annual Conference, American Library Association, Washington, D.C., June 23, 2007.

Hall-Ellis, Sylvia D. *Cataloging Education: A New Emphasis for the Library and Information Science Curriculum*. Presentation delivered to the ALCTS Pre-conference, 132nd Annual Conference, American Library Association, Washington, D.C., June 22, 2007. <http://www.loc.gov/catdir/cpsocareercat.html>

Ellett, Jr., Robert O. and Sylvia D. Hall-Ellis. *Copy Cataloging Done Smarter*. Presentation delivered to the International Conference on Interdisciplinary Information Sciences and Technologies (InSciT2006), October 25-28, 2006.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Challenges and Opportunities for Defense Libraries*. Presentation delivered to the 1st Annual Conference of Defense Libraries, Spanish Ministry of Defense, Madrid, Spain, July 7, 2006.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation delivered to the ALCTS CCS Heads of Cataloging Discussion Group, 131st Annual Conference, American Library Association, New Orleans, La., June 26, 2006.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *From Research to Practice: The Scholarship of Teaching and Learning in LIS Education*. Presentation delivered to the at the 92nd Annual Conference, Association for Library and Information Science Education, San Antonio, Tex., January 18, 2006.

Hall-Ellis, Sylvia D. *Employers' Expectations for Entry-Level Catalogers: What Position Announcement Data Indicate*. Research paper delivered to the Technical Services Special Interests Group, 91st Annual Conference, Association for Library and Information Science Education, Boston, Mass., January 12, 2005. <http://dlist.sir.arizona.edu/>

Hall-Ellis, Sylvia D. *Common Errors in MARC Records Prepared by LIS Students: What Does It Mean?* Research paper delivered to the ALCTS CCS Cataloging Norms Discussion Group, Mid-Winter Conference, 90th American Library Association, San Diego, Calif., January 10, 2004.

Hall-Ellis, Sylvia D. *Visual Arts as Foundation for Successful Library Automation: The Rocky Mountain College of Art & Design Experience*. Paper delivered at the 6th Annual Conference of Higher Education, Charleston, S. C., 1993.

Hall, Sylvia D. *Design Elements for Bibliographic Databases: An Overview*. Paper delivered at the 14th Online National Conference, New York, 1983.

Invited Regional Conference Presentations

Hall-Ellis, Sylvia D., Hudson, Christopher D., Brittany Cronin, and Kathryn Michaels. "The Colorado Law Project: Meeting the Public's Need for Legal Information." Panel discussion delivered at the Mountain Plains Library Association Conference, Billings, Mont., April 9, 2011.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Education for Information Professionals in New Mexico: Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the New Mexico Library Education Summit, Las Vegas, N.M., September 26, 2005.

Hall-Ellis, Sylvia D. *Public Library-School Library Partnerships*. Presentation delivered at the 3rd Annual Colorado Association of Libraries Conference with the Mountain Plains Library Association, Denver, Colo., October 22, 2004.

Hall-Ellis, Sylvia D. *Learn All You Can – Educational Partnership Opportunities for the Lewis and Clark Bicentennial Commemoration*. Paper delivered at the 3rd Annual Lewis and Clark Bicentennial Council National Planning Conference, Bismarck, N.D., April 26, 1998.

Invited State Conference Presentations

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Academic Library Leadership Changes: Using Succession Planning and Mentoring*. Presentation delivered at the Minnesota Library Education Conference, St. Cloud, Minn., October 10, 2013.

Hall-Ellis, Sylvia D., Merrie Valliant, and Melissa Powell. *RDA: What Is It and What Do You Need To Do With It At Your Library?* Presentation delivered at the Colorado Library Consortium Spring Conference, Ft. Morgan, Colo., April 26, 2013.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 4th LEADS Scholars Orientation, Denver, Colo., August 5, 2009.

Hall-Ellis, Sylvia D. *Service Learning: Enhancement to Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 3rd LEADS Scholars Orientation, Denver, Colo., June 2008.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation*. Sponsored by the Colorado Association of Law Libraries. Paper delivered at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. *Opportunities and Challenges in Law Librarianship: A Community Conversation*. Presentation delivered at the Sturm College of Law, Denver, Colo., November 7, 2007.

Ellis, Sylvia D. *Grant Writing Resources for Nursing Professionals*. Presentation delivered at the Presbyterian / St. Luke's Health One Medical Center 1st Annual Research Symposium, Denver, Colo., October 17, 2007.

Hall-Ellis, Sylvia D. *Project Homeless Connect 4 Event Evaluation – Insights and Lessons Learned*. Presentation delivered at the Homelessness Research Symposium: What is DU Doing about Homelessness in Denver, Denver, Colo., September 14, 2007.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 2nd LEADS Scholars Orientation, Denver, Colo., August 10, 2007.

Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 15th Spring Mountains and Plains Paraprofessionals Conference, Denver, Colo., February 24, 2007.

Hall-Ellis, Sylvia D. *Public Library Service to Spanish-Speaking and Latino Residents in Denver: A Case Study*. Presentation delivered at the 4th Annual Colorado Association of Libraries Conference, Denver, Colo., November 10, 2005.

- Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 14th Annual Mountains and Plains Parapros Conference, Aurora, Colo., July 29, 2005.
- Hall-Ellis, Sylvia D. *Educational Opportunities: Library & Information Science Graduate Education at the University of Denver*. Presentation delivered at the 13th Annual Mountains and Plains Parapros Conference, Centennial, Colo., August 6, 2004.
- Hall-Ellis, Sylvia D. *Library Education & Training: Focus on the West: An LIS Faculty Member's Personal Response*. Presentation delivered at the 1st Annual Colorado Association of Libraries Conference, Keystone, Colo., October 18, 2002.
- Hall-Ellis, Sylvia D. *Grant Writing for School Librarians*. Presentation delivered at the 2002 Annual Colorado Education Media Association Conference, Colorado Springs, Colo., February 15, 2002.
- Hall-Ellis, Sylvia D. *Grants – Opportunities for the Future*. Paper delivered at the Southeast Regional Accountability Annual Conference, Lamar, Colo., November 12, 1998.
- Hall-Ellis, Sylvia D. *The Texas Library Connection and Interlibrary Loan: An Experiment in Resource Sharing*. Paper delivered at the Texas Computer Educators' Association Annual Conference, Austin, Tex., February 6, 1997.
- Hall-Ellis, Sylvia D. *Finding Grant Sources on the Internet: A Guide for Librarians*. Paper delivered at the 2nd Annual Institute for School Library Personnel, Pharr-San Juan-Alamo North High School, Pharr, Tex., July 29, 1996.
- Hall-Ellis, Sylvia D. *Mathematical and Logical Thinking: A Critical Intelligence*. Paper delivered at the 3rd Annual Paraprofessional Conference at the University of Texas - Pan American, Edinburg, Tex., March 8, 1996.
- Hall-Ellis, Sylvia D. *Cataloging Trends and Issues: Update Session*. Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 19, 1995.
- Hall-Ellis, Sylvia D. *Grant Writing: Tips and Encouragement for School Librarians*. Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 18 and 19, 1995.
- Hall-Ellis, Sylvia D. *How to Become an Expert Grant Writer*. Paper delivered at the 3rd Annual High School Principals' Academy, South Padre Island, Port Isabel, Tex., June 19, 1995.
- Texas Library Study: Results from Regions I and II*. Paper delivered at the 3rd Annual Technology Conference, Texas A&M University, College Station, Tex., November 18, 1994.
- Hall-Ellis, Sylvia D. *Academic Achievement and Middle School Students*. Paper delivered at the 8th Annual Young Adult Conference, Sam Houston State University, Huntsville, Tex., November 5, 1994.
- Hall-Ellis, Sylvia D. *Multimedia Resources for Library Leaders*. Paper delivered at the Institute for Librarians in A Multicultural Environment, Sam Houston State University, Huntsville, Tex., June 10, 1994.
- Hall-Ellis, Sylvia D. *Finding the Resource: Empowering the User, or, the Case for Curriculum Based Subject Access to Learning Resource Center Collections*. Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.
- Hall-Ellis, Sylvia D. and William H. Pichette. *Sam Houston State University Makes Use of OCLC/AMIGOS Collection Analysis CD*. Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.

Hall, Sylvia D. *Funding and Library Development in Pennsylvania: A Symbiotic Relationship*. Paper delivered at the Annual Graduate Student Colloquia, University of Pittsburgh, School of Library and Information Science, 1982.

Hall, Sylvia D. *Leadership for Public Library Trustees*. Paper delivered for the Trustees Division, Pennsylvania Library Association Annual Conference, Lancaster, Penn., 1981.

Seminar and Professional Development Presentations

Taylor, Meredith, and Sylvia D. Hall-Ellis. *Talent Management and Succession Planning*. ALCTS eForum, held March 22, 2017.

Hirsh, Sandra, Heather O'Brien, Michelle Holschuh Simmons, Michael Krasulski, and Sylvia D. Hall-Ellis. *Information Services Today: An Introduction. Part 3: Information Services: Roles in the Digital Age*. Rowan and Littlefield in partnership with Library Journal webinar, recorded February 5, 2015.

Hall-Ellis, Sylvia D. and Jennifer Sweda. *Copy Cataloging in an RDA Environment*. ALCTS eForum, held May 14 and 15, 2013.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation*. Sponsored by the Colorado Association of Law Libraries, presented at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. and Beatrice Z. Gerrish. *Reading and Libraries: Recent Research in Reading*. Presentation at the Ricks Center for Gifted Education, Denver, Colo., March 4, 2008.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation for the School of Library and Information Science, San José State University, February 12, 2008.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Rules, Tools, and Conventions for Building a Multi-institutional Catalog*. Sponsored for the Spanish Ministry of Defense, Madrid, Spain, July 10, 2006.

Hall-Ellis, Sylvia D. *Cash for Kids: Grant Writing Opportunities for Youth Services Librarians*. Sponsored by the Colorado Young Adult Librarians; presented at Bemis Memorial Library, Littleton, Colo., November 13, 2002.

Hall-Ellis, Sylvia D. *MARC Records and Authority Control: Planning for Bibliographic Database Migration*. Sponsored and held at the Douglas County Public Library, Castle Rock, Colo., May 28, 2002.
Grant Writing: A Refresher for Librarians. Sponsored by Library and Information Science Program, College of Education, University of Denver; presented at University Center at Chaparral, August 12, 2000.

Hall-Ellis, Sylvia D. *Shaking the Money Tree – Basic Grant Writing for Colorado Educators*. Sponsored by the Office of Educational Telecommunications of the Colorado Department of Education.
 Pikes Peak Community College, Colorado Springs, Colo., November 16, 1998.
 Pueblo School District 60, Pueblo, Colo., November 12, 1998.
 University of Northern Colorado, Greeley, Colo., November 10, 1998.
 United Technology Educational Partnership, Grand Junction, Colo., November 9, 1998.

Hall-Ellis, Sylvia D. *Cataloging Multimedia, Kits, Globes and Map Materials in USMARC*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 24, 1997 and December 12, 1996.

Hall-Ellis, Sylvia D. *New Standards for School Library Media Centers*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 15, 1997.

- Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future*. Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., April 4, 1997.
- Hall-Ellis, Sylvia D. *Cataloging Sound Recordings and Audio Materials in USMARC*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 20, 1997 and November 21, 1996.
- Hall-Ellis, Sylvia D. *Evaluating and Selecting CD-ROMS for School Library Media Collections*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 18, 1997.
- Hall-Ellis, Sylvia D. *Cataloging Audiovisual Materials in USMARC*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 27, 1997, November 7, 1996 and October 24, 1996.
- Hall-Ellis, Sylvia D. *Introduction to Dialog: Basic Searching Strategies*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 14, 1997.
- Hall-Ellis, Sylvia D. *Cataloging Books in USMARC*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 30, 1997, October 10, 1996, September 26, 1996 and August 8, 1996.
- Hall-Ellis, Sylvia D. *Advanced Internet Searching Techniques for Librarians*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 21, 1997.
- Hall-Ellis, Sylvia D. *Texas Library Connection Full-Text Searching*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 13, 1996 and October 25, 1996.
- Hall-Ellis, Sylvia D. *Developing Evaluation Strategies for Grants and Proposals*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 10, 1996.
- Hall-Ellis, Sylvia D. *Developing Needs Assessment for Grants and Proposals*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 12, 1996.
- Hall-Ellis, Sylvia D. *Texas Library Connection Union Catalog Searching*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 8, 1996 and September 6, 1996.
- Hall-Ellis, Sylvia D. *Grant Resources on the Internet*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 23, 1996.
- Hall-Ellis, Sylvia D. *Preparing a Response to the Telecommunications Infrastructure Fund Board: Needs Assessment, Professional Development Framework, and Evaluation Strategies*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 16, 1996.
- Hall-Ellis, Sylvia D. *Texas Library Connection: Building the Districtwide Bibliographic Database*. Sponsored and hosted by Mercedes Independent School District, Mercedes, Tex., September 13, 1996 and August 8, 1996. Sponsored and hosted by Los Fresnos Consolidated Independent School District, Los Fresnos, Tex., August 12, 1996.
- Hall-Ellis, Sylvia D. *School-to-Work and Special Education: An Inclusive Partnership for Success*. Sponsored and hosted by the Office of Special Education, Region One Education Service Center, Edinburg, Tex., September 11, 1996.
- Hall-Ellis, Sylvia D. *Telecommunications Infrastructure Fund Board: An Overview of Funding for Secondary Schools*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., August 31, 1996.
- Hall-Ellis, Sylvia D. *Cataloging Books, Multimedia, and Realia in USMARC*. Sponsored and hosted by Edinburg Consolidated Independent School District, Edinburg, Tex., August 6, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers*. Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 20, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills for Mathematics Educators: Writing Skills for Campus Teams*. Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 22, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers*. Sponsored and hosted by the College of Education and Applied Science, Sam Houston State University, Huntsville, Tex., March 9, 1996.

Hall-Ellis, Sylvia D. *Grant Writing for Mathematics Educators: A Development Process for Campus Teams*. Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 4, 1996.

Hall-Ellis, Sylvia D. *Shaking the Money Tree: Preparing Successful Technology Grant Applications*. Sponsored and hosted by the Office of Technology and Media Services, Region One Education Service Center, Edinburg, Tex., February 29, 1996 and April 29, 1996.

Hall-Ellis, Sylvia D. *District-wide Technology Planning: Technical Assistance for the Texas Education Agency Initiative*. Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., February 2, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills*. Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 27, 1996.

Hall-Ellis, Sylvia D. *United States Copyright Act of 1976, Video Transmissions, Computer Software and the Internet*. Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., January 24, 1996.

Hall-Ellis, Sylvia D. *The Grant Writing Development Process*. Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 20, 1996.

Hall-Ellis, Sylvia D. *MARC Cataloging of Materials for Library Media Centers*. Sponsored and hosted by the Office of Media Services, Region One Education Service Center for the Donna Independent School District, Donna, Tex., August 17, 1995.

Hall-Ellis, Sylvia D. *Classification*. Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 10, 1995.

Hall-Ellis, Sylvia D. *Library Technical Services*. Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., April 26, 1995.

Hall-Ellis, Sylvia D. *Grant Writing: An Introduction for Public School Administrators*. Sponsored and hosted by the Office of Administrative Services, Region One Education Service Center, Edinburg, Tex., April 19, 1995.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future*. Sponsored and hosted by the United Independent School District, Laredo, Tex., March 31, 1995.

Hall-Ellis, Sylvia D. *Using USMARC*. Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 29, 1995.

Hall-Ellis, Sylvia D. *Library Media Center Policies and Guidelines: How to Prepare for School Board Adoption*. Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., March 10, 1995.

Hall-Ellis, Sylvia D. *Developing District-wide Policies and Guidelines for Library Media Centers*. Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., January 10, 1995.

Hall-Ellis, Sylvia D. *MARC Cataloging of Audiovisual Materials for Library Media Centers*. Sponsored and hosted by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., December 1, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future*. Sponsored and hosted by United Independent School District, Laredo, Tex., October 14, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future*. Sponsored and hosted by the Laredo Independent School District, Laredo, Tex., October 7, 1994.

Hall-Ellis, Sylvia D. *MARC Cataloging for Library Media Centers*. Sponsored by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., October 5, 1994.

Hall-Ellis, Sylvia D. *Jump to the Head of the Class: Undergraduate Library Resources Available at Sam Houston State University*. Sponsored by the Office of the Associate Vice President for Student Services, Sam Houston State University, Huntsville, Tex., October 4, 1994.

Hall-Ellis, Sylvia D. *CD-ROMs - 1994's Newest and the Best for Secondary Level Media Centers*. Sponsored and hosted by Clear Lake Independent School District, Houston, Tex., June 3, 1994.

Hall-Ellis, Sylvia D. *Introduction to Classification*. Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., May 18, 1994.

Hall-Ellis, Sylvia D. *Basic Descriptive Cataloging*. Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part II: Writing Successful Grant Applications*. Sponsored by Donna Independent School District, Donna, Texas, and Region One Education Service Center Edinburg, Texas; presented at South Texas Community College Library, McAllen, Tex., April 29, 1994.

Hall-Ellis, Sylvia D. *Using MARC*. Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., April 6, 1994.

Hall-Ellis, Sylvia D. *Automated Authority Control*. Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 23, 1994.

Hall-Ellis, Sylvia D. *Automating the District School Library Media Centers: Choices and Opportunities*. Sponsored and hosted by the Office of Technology and Library Media Services, Fort Bend Independent School District, Sugar Land, Tex., March 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part I: Preparing Successful Grant Applications*. Sponsored and hosted by the Office of Library Media Services, Donna Independent School District, Donna, Tex., February 4, 1994.

GRADUATE COURSES TAUGHT

San José State University, School of Library and Information Science

INFO 249 – Advanced Cataloging and Classification (Fall 2015, 2016; Summer 2016)
INFO 287 – Special Topics in Cataloging and Classification (Spring 2017, 2018, 2019, 2020, 2021, 2022, 2023; Fall 2020, 2021, 2022)
LIBR 248 – Beginning Cataloging and Classification (Summer 2002, 2003, 2004, 2005, 2006)
LIBR 249 – Advanced Cataloging and Classification (Summer 2003; Fall 2014; Summer 2015)

University of Denver, University College

Grant Writing Certificate Seminar for Non-Profit Organizations (Fall 2020, 2021; Spring 2021)

University of Denver, Morgridge College of Education HED

5991 – Grant Writing in Higher Education (Spring 2011)
LIS 4010 – Organization of Information (Fall 2002-2009; Winter 2005; Spring 2004-2006)
LIS 4020 – Professional Principles and Ethics (Summer 2000)
LIS 4040 – Management of Libraries and Information Centers (Fall 2010; Spring 2003, 2009 (DS); Winter 2005)
LIS 4070 – Cataloging and Classification (Winter 2008, 2009, 2010, 2011, 2012; Fall 2009 (DS)) LIS
4321 – Collection Management (Spring 2005)
LIS 4326 – LIS Research (Winter 2009 (DS); Spring 2009 (DS))
LIS 4350 – Adult Materials and Services (Summer 2006, 2009)
LIS 4379 – Social Sciences Resources (Spring 2009)
LIS 4400 – Cataloging and Classification (Spring 2000, 2001; Winter 2002-2009; Summer 2005, 2006 – course renumbered LIS 4070, September 2007)
LIS 4401 – Descriptive Cataloging (Winter 2001; Spring 2002, 2003, 2006-2009; Summer 2005)
LIS 4402 – Subject Cataloging (Spring 2001, 2009; Summer 2005, 2006, 2007, 2008)
LIS 4403 – Classification Schemes (Fall 2007, 2008, 2009 (DS)) LIS
LIS 4405 – Authority Control (Winter 2009)
LIS 4510 – Materials and Services for Children (Winter 2004; Summer 2005)
LIS 4620 – Grant Writing and Fundraising (Summer 2000, 2002, 2004, 2010; Winter 2006; Fall 2006-2009)
LIS 4700 – Seminar in Technical Services (Fall 2001)
LIS 4700 – Seminar in Public Libraries (Summer 2002)
LIS 4804 – Management of Electronic Records (Spring 2004; Fall 2005)
LIS 4902 – Capstone Projects (Winter 2003, Spring 2008, 2009, 2011)
LIS 4910 – Independent Study (every quarter Winter 2000 through Spring 2011)
LIS 4920 – Service Learning (every quarter Summer 2004 through Spring 2011)
RMS 4954 – Grant Writing (Summer 2013, 2014)
RMS 4959 – Content Analysis Methodology (Spring 2015)
QRM 4978 – Grant Writing (Summer 2011, 2012)

Rutgers University, School of Communication and Information

SC&I 522 – Cataloging and Classification (Summer 2013)

University of Arizona, College of Behavioral and Social Sciences

LIS 602 – Cataloging and Classification (Summer 1995)
LIS 612 – Advanced Online Search and Retrieval (Summer 1995)

Sam Houston State University, College of Education & Applied Science

LIS 532 - Cataloging and Classification (Fall 1993, 1994, 1995)
LIS 563 - Advanced Cataloging and Classification (Summer 1994)
LIS 567 - Research Methods (Spring 1994, Spring 1995)
LIS 591 - Educational Technology (Spring 1994, 1995)
LIS 596 - Networking and Computer Technologies in Education (Fall 1993, Summer 1994, Fall 1995)

Dissertations at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale*. Chair, May 5, 2010.

Fattor, Melissa M. *Student Engagement Differences by Ethnicity and Scale for Ninth Grade Students*. Chair, November 1, 2010.

Fulton, Roseanne. *A Case Study of Culturally Responsive Teaching in Middle School Mathematics*. Kent Seidel, Chair, June 18, 2009, Outside Chair.

Greal, Deborah S. *Tribes and Territories in Library and Information Studies Education*. Bruce Uhrmacher, Chair, June 10, 2008, Committee Member.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice*. Chair, April 15, 2011.

Priebe, Sarah J. *Distinguishing Effects of Domain and General Knowledge on Passage Fluency and Comprehension*. Jan Keenan, Chair. July 21, 2011, Outside Chair.

Snyder-Mondragon, Sandra M. *Institutional Factors that Impact the Retention of Graduate Students of Color in Schools of Library and Information Science: A Metaregression of Accredited Library School Statistics on Student Retention and Graduation Rates*. Kathy Green, Chair, July 24, 2009, Committee Member.

Taylor, Karen Pickles. *Effective Teaching*. Elinor Katz, Chair, July 15, 2009, Outside Chair.

Thompson, Jennifer. *Distinguishing a Western Women's College: A History of the Curriculum and Student Experience at Colorado Women's College*. Edith W. King, Chair, July 16, 2010, Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions*. Chair, April 29, 2010.

Dissertation Proposals at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale*. Chair, November 5, 2009.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice*. Edith W. King, Chair. April 23, 2010.

Thompson, Jennifer. *History of Colorado Women's College*. Edith W. King, Chair, October 30, 2008. Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions*. Chair, July 21, 2009.

Dissertations at Other Institutions

Rodríguez-Mori, Howard. *The Information Behavior of Puerto Rican Immigrants to Central Florida, 2003-2009: Grounded Analysis of Six Case Studies Use of Social Networks during the Migration Process*. Kathleen Burnett, Chair, April 10, 2009, Florida State University, Committee Member.

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools*. D. Mirah Dow, Chair, July 18, 2017. Emporia State University, Committee Member.

Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers*. Shawne D. Miksa, Chair, August 1, 2011. University of North Texas, Committee Member.

Dissertation Proposals at Other Institutions

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools*. D. Mirah Dow, Chair, December 4, 2015. Emporia State University, Committee Member.

Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers*. Shawne D. Miksa, Chair, May 11, 2010. University of North Texas, Committee Member.

Master's Thesis at the University of Denver

Hemingson, Jeff. *Recital Paper*. Lamont School of Music, February 2010, Outside Chair.

Capstones at the University of Denver

Anthony, Alisa. *Correlation of Library and Information Science Program outcomes and Vacant Position Qualifications Listed on the Colorado State Library Jobline by Employers During the Period September 1, 2000 through August 31, 2002*. Chair, Winter Quarter, 2003.

Borden, Donna M. *Improving Emergency Communications Systems: Is a Radio Communications Network the Answer?* Fall Quarter, 2014.

Bowden, Heather L.M. *Exploring Biological Models for Long-term Data Preservation*. Chair, Spring Quarter, 2008.

Casenada, Cassandra Y. *Challenges to the Recruitment, Education, and Retention of Librarians of Color*. Chair, Spring Quarter, 2008.

Chang, Jennifer C. *Legal Research Practice and Preference: A Law Firm Perspective*. Chair, Spring Quarter 2011.

Ellis, Megan S. Fitzgerald. *Design of a Public Library Adult Volunteer Recruitment Program and Training Curriculum*. Chair, Winter Quarter, 2003.

Kircher, Kathy. *Development of a Library Pathfinder for Exobiology and Posting it on the Internet*. Chair, Winter Quarter, 2003.

Melhado, Loretta. *Design of St. John's Episcopal Church Library*. Chair, Spring Quarter, 2008.

Radcliff, Kathy. *Original Cataloging of Archival materials in the HERS Collection in Penrose Library*. Chair, Winter Quarter, 2003.

Sass, Carol Ann. *ACT Periodical Index: Access to Catholic Thinking Periodical Index: Web Index to Select Catholic Periodicals*. Spring Quarter 2000.

Stone, Sergio D. *Conducting Community Analysis for the Bemis Public Library (Littleton, Colorado) Using 2002 U.S. Census Data and the Online Outcome-Based Evaluation Toolkit*. Chair, Winter Quarter, 2003.

Tureson, Tamara. *Design and Use of an Information Audit Tool for Use in a Law Library*. Chair, Winter Quarter, 2003.

Tweed, Beth. *Evaluation of Email Reference Service in a Consumer Health Library Environment*. Chair, Winter Quarter, 2003.

GRANTS AND CONTRACTS

Student Learning in Agriculture STEM through Teacher Professional Development. Research team: Stanton Gartin (PI) and Cyndi Hofmeister, Northeast Junior College; Jeff Cash, Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Jack Wiley, Kerry Gabrielson, Trinidad State Junior College; Michael J. Miller, Colorado State University; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Agriculture and Food Research Initiative, Food, Agriculture, Natural Resources and Human Sciences Education and Literacy Initiative, \$404,460 (2017-2020)

Leading and Achieving: the Colorado Agriculture Regional Consortium. Research team: Jack Wiley (PI), Kerry Gabrielson, Trinidad State Junior College; Jeff Cash (PI), Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Cyndi Hofmeister, Northeast Junior College; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Hispanic Serving Institutions Education Grants Program, \$504,414 (2017-2020)

Cyber Prep Program Planning Grant. Research team: Debbie Sagen (PI), Brenda Lauer, Pikes Peak Community College; Gretchen Martin, Koiosa Insights; and, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Commerce, Regional Alliances and Multi-stakeholder Partnerships to Stimulate (RAMPS) Cybersecurity Education and Workforce Development, \$199,681 (2016-2018)

Career and Technical Education in Colorado: Pathways to Education and Employment. Research team: Heather McKay (PI), Rutgers University; Sarah Heath, Casey Sacks, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, Institute of Education Sciences, \$1,400,000 (2017-2021)

Pre-Alliance Planning Grant Colorado Community College Alliance. Research team: Victor Vialpondo (PI) and Janel Highfill, Community College of Aurora; Heidi Loshbaugh (Co-PI), Community College of Denver; Rick Reeves, Bill McGreevy, Liz Cox, and Kristin Aslin, Red Rocks Community College; Cathy Pellish, Front Range Community College; Samuel DeVries, Arapahoe Community College; Sylvia D. Hall-Ellis, Colorado Community College System. National Science Foundation, Louis Stokes Alliance for Minority Participation (LSAMP), \$86,817 (2016-2017)

Towards Scalable Differentiated Instruction Using Technology-enabled, Competency-based, Dynamic Scaffolding. Research team: Karen Wilcox (PI) and Vijay Kumar, Center for Computational Engineering, Massachusetts Institute of Technology; Flora McMartin, Broad-based Knowledge; Quinsigamond Community College; and, Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, First in the World Developmental Grant, \$2,891,882 (2015-2019)

Colorado Strategic Partnerships Emergency Grant. Research team: Elise Lowe-Vaughn (PI), Amy Hodson, Celia Hardin, Barbara McBride, James Newby, Christopher Dewhurst, Nina Holland, Kate Anderson, MaryAnn Roe, Chrystalynn Chrystalynn, Elaine Edon, Mona Barnes, Tom Morgan, Rob Hanni, and Marie Valenzuela, Colorado Department of Labor and Employment; Steve Anton, Joelle Brouner, and, Katie Griego, Colorado Department of Human Services; Rebecca Holmes, Judith Martinez, and Jennifer Jirous, Colorado Department of Education; Emily Templin Lesh, Colorado Workforce Development Council; Cory Everett, Colorado Department of Regulatory Agencies; and, Casey Sacks and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Labor, Strategic Partnerships Emergency Grant, \$5,000,000 (2015-2017)

CAEL Jump Start Program: Competency-Based Education. Research team: Jerry Migler (PI), Casey Sacks, Debra Cohn, Thomas Hartman, and Sylvia D. Hall-Ellis, Colorado Community College System; Matt Jamison, Front Range Community College; Mike Coste, Red Rocks Community College; Amanda Corum, Pueblo Community College; Janet Colvin, Pikes Peak Community College; and, MaryAnn Matheny, Community College of Denver. Council for Adult and Experiential Learning, \$15,000 (2015)

Summit on the Redesign of Developmental Education. Research team: Jerry Migler (PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System; Chip Nava, Pueblo Community College; Kim Moultney, Arapahoe Community College; Debbie Ulibarri, Trinidad State Junior College; and, Kris Bernard, Front Range Community College. American Association of Community Colleges, \$15,000 (2015-2016)

Equity in Excellence at Colorado Community Colleges. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Estela Mata Bensimon, Center for Urban Education, University of Southern California; and Kerry Gabrielson, Trinidad State Junior College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, \$150,000 (2015-2016)

MBA High School of Business in Colorado. Research team: Laurie Urich (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Rudolph Sumpter and Beatrice Gerrish, Boulder Valley Schools; Keith Curry Lance, RSL Research Group. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, \$501,295 (2015-2016)

Fullbridge Program in Colorado. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Suzanna Spears, Fort Morgan Community College; and, Cheryl Sánchez and Anne-Marie Compton, Lamar Community College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, \$300,000 (2015-2017)

Colorado Community College System Alternative Credit Program. Research team: Jerry Migler (PI), Keith Howard, and Sylvia D. Hall-Ellis, Colorado Community College System. American Council on Education, \$13,000 (2015)

Internationalization in Higher Education. Researcher: Samuel D. Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$8,000 (2014-2015)

International Perspectives on Bilingual Education. Researcher: Sharolyn Pollard-Durodola. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$3,700 (2014-2015)

Cultivating Culturally Relevant and Responsive Curriculum and Pedagogy in College. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, iRise Grant, \$5,000 (2014-2015)

Project EMERGE (Educational Model for Evaluation and Replicability in Gifted Environments). Research team: Norma Hafenstein (PI) and Bruce Uhrmacher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Lynde and Harry Bradley Foundation, \$235,000 (2014-2015)

Collecting Asian American Refugee Stories. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. American Educational Research Association, Research Grant, \$5,000 (2014-2015)

Developing Expertise in Teaching K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas H. Clements (Co-PI), in partnership with the School of Education at the University of Michigan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, \$130,344 (2013-2015)

Investigation of the Long-Term Outcomes for Special Education Students. Researcher: Antonio Olmos-Gallos. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Jefferson County School District, Office of Assessment, \$40,000 (2014)

Refugee Community Collaboration. Researcher: Vicki Tomlin (PI) in partnership with the African Community Center and Jewish Family Service. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, \$14,854 (2014-2015)

Access to Mathematics for All. Research team: Richard S. Kitchen (PI), Nicole M. Russell (Co-PI), and Terrence Blackman (Co-PI), Curriculum Studies and Teaching Program, Morgridge College of Education; Álvaro Árias (Co-PI, Department of Mathematics); and, James Gray (Co-PI), Department of Mathematics, Community College of Aurora. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, The Robert Noyce Scholarship Program, Capacity Building Project, \$349,926 (2014-2016)

Cognitive Test Battery for Intellectual Disabilities. Research team: Karen Riley (PI), Lyndsay Agans, Jessica Lerner, and Karin Dittrock-Nathan in partnership with David Hessel (PI), The MIND Institute at the University of California – Davis, and Elizabeth Berry-Kravis, Rush University Medical Center. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Institutes of Health, Outcome Measures for Use in Treatment Trials for Individuals with Intellectual and Developmental Disabilities (R01), \$2,499,996 (\$588,672 at DU) (2014- 2019)

Broadening Participation in Engineering among Women and Latino/as: A Longitudinal, Multi-Site Study. Researcher: Patton Garriott (PI) in partnership with the University of North Dakota and the University of Missouri. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, HER Core Research, \$677,390 (\$69,992 at DU) (2014-2019)

Designing a Teacher Evaluation System to Improve Teacher Effectiveness for Culturally and Linguistically Diverse Learners. Research team: María del Carmen Salazar (PI), Jessica Lerner, and Kathy Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, \$29,988 (2014-2016)

Developing a College-Going Culture in Latina/O Families: Exploring the Influence of Funds of Knowledge on Family Outreach Programs. Researcher: Judy Marquez Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, \$18,720 (2014-2016)

Assessment of Quality of Life in Neural Implantation Surgery for the Treatment of Parkinson's Disease. Researcher: Cynthia McRae. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$3,967 (2014-2015)

Pura Vida: Cloud Forest, Curriculum and Cross-Cultural Study. Research team: Norma Hafenstein (PI) and Bruce Uhrmacher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$8,000 (2014-2015)

Online Course Development for Curriculum and Instruction. Researcher: Ruth Chao. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: María del Carmen Salazar. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Jessica Lerner. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$3,000 (2014)

The Mathematics Education of African Americans, 1866 – 1954. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, \$55,000 (2014-2016)

Early Childhood Care and Education Study. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota, Department of Public Instruction, \$73,500 (2013-2014)

Graduate Level Specialty in Addiction Counselor Training with Emphasis on Integration of Native American Specific Content. Research team: Ruth Chao (PI) and Michael J. Faragher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Galena Foundation, \$289,732 (2013-2016)

The Collecting Asian American and Pacific Islander Refugee Stories (CARS) Project. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, \$15,000 (2014)

Parents in Transition: A Multiple Case Study of Parent and Family Orientation Programs. Researcher: Judy Marqu  z Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, \$1,500 (2014-2015)

The Sistah Network: Black Women Graduate Students Supporting and Retaining Each Other. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, \$2,708 (2014-2015)

Evaluation of the Northeast Denver Babies Ready for College Program. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High Montessori, \$9,922 (2013-2014)

Developing Teaching Expertise in K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas Clements (University of Denver), in partnership with Timothy Boerst (PI), Meghan Shaughnessy, Deborah Ball, Hyman Bass (School of Education at the University of Michigan). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, \$449,827 (\$130,344 at the University of Denver (2013-2015)

Early Learning Care and Education Study Program Grant for the State of North Dakota. Research team: Carrie Germeroth (PI), Melissa Mincic, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota Department of Public Instruction, \$73,500 (2013-2014)

Local Professional Learning Community for School Leaders. Research team: Susan Korach (PI), Kristina Hesbol, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Education Development Center, \$10,950 (2013)

Healthy Eaters, Lifelong Movers 2: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado. Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, \$3,103,108 (2013-2017)

Hughes Rare Books Library Room Renovation in the Sturm College of Law. Project team: Patti H. Marks, Sylvia D. Hall-Ellis, and Leigh Elliott. Mabel T. Hughes Charitable Trust, \$34,000 (2013-2014)

The Promise Center Partnership with the Marsico Institute for Early Learning and Literacy and the City and County of Denver. Research team: Karen Riley (PI), Douglas H. Clements (Co-PI), and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Piton Foundation, \$223,468 (2013-2014)

Center of Excellence for Problem Gambling. Research team: Ruth Chao (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, \$68,021 (2012-2013)

United Way Implementation and Validation Review. Research team: Douglas H. Clements (PI), Amanda Moreno, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, \$19,737 (2013)

Math/Science Partnership in Rural Districts. Research team: Kristen Bunn (PI, Eagle County Schools), Paul Michalec (Co-PI), and Alegra Reiber. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Colorado's Mathematics and Science Partnership Program, \$750,000 (2013-2014)

Mathematics and Science Education of African Americans. Research team: Nicole Russell (PI), Sylvia D. Hall-Ellis, Steve Fisher (Penrose Library). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, \$29,994 (2013-2015)

Online Course Development for Curriculum and Instruction. Researcher: Nicole Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$3,000 (2013)

Discourse and Opportunity: Undocumented Students and Higher Education Policy. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, \$55,000 (2012-2014)

An Anthropological Study of the Latino Graduation Ceremony. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Spencer Foundation, \$39,900 (2012-2013)

Fragile-X and Pharmaceutical Company: Clinical Trial of AFQ056. University of California – Davis Children's Hospital MIND Institute (Sacramento), Children's Hospital Denver, and Rush Children's Hospital at Rush University Medical Center (Chicago). Karen Riley, PI. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Novartis Pharmaceuticals Corporation, \$394,206 (2012-2014)

Project Engage, Phase 2, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University. Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, \$60,000 (2011-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, \$14,951 (2012-2013)

Online Course Development for Curriculum and Instruction. Research team: Bruce Uhrmacher (PI) and Norma Hafenstein (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, \$18,193 (2012-2014)

Writers in the Schools. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Humanities, \$4,965 (2012-2013)

Learning Ecosystem Validation Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, \$315,000 (2012-2013)

Project Words of Oral Reading and Language Development (WORLD). Research team: Jorge E. Gonzalez (PI), Texas A&M University; Laura Saenz (Co-PI), University of Texas – Pan American; and, Sharolyn Pollard-Durodola (Co-PI), University of Denver. Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, \$53,354 (2012-2015); award \$640,718, transfer from Texas A&M University

Increasing the Efficacy of an Early Mathematics Curriculum with Scaffolding Designed to Promote Self-Regulation.

Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, \$1,445,315 (2008-2014); award \$4,541,975, transfer from University at Buffalo, The State University of New York

Using Rule Space and Poset-based Adaptive Testing Methodologies to Identify Ability Patterns in Early

Mathematics and Create a Comprehensive Mathematics Ability Test. Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, \$323,791 (2010-2014); award \$1,194,944, transfer from University at Buffalo, The State University of New York

Comprehensive Postdoctoral Training in Scientific Education Research. Researcher: Julie Sarama (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, \$133,458 (2010-2014); award \$613,353, transfer from University at Buffalo, The State University of New York

Longitudinal Study of a Successful Scaling Up Project: Extending TRIAD. Research team: Douglas H. Clements (PI), Julie Sarama (Co-PI), and Abt Associates (Carolyn Layzer, Fatih Unlu, Laurie Bozzi, Lily Fesler, Alina Martinez, Cristofer Price, James van Orden). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, \$384,940 (2011-2015); award \$1,250,286, transfer from University at Buffalo, The State University of New York

Early Childhood Education in the Context of Mathematics, Science, and Literacy. Research team: Julie Sarama (PI), Douglas H. Clements (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, \$990,020 (2010-2014); award \$2,285,228, transfer from University at Buffalo, The State University of New York

Early Childhood Clearinghouse Information Center Redesign. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Office of the Lt. Governor of Colorado, \$12,000 (2012-2013)

Morgridge Rural Educational Leadership Initiative. Research team: Lyndsay Agans (PI), Linda Brookhart (Co-PI), Susan Korach, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, \$100,000 (2012-2014)

Center of Excellence for Problem Gambling. Research team: Patrick Sherry (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, \$55,000 (2012-2013)

Intermodal Transportation Institute Research Initiatives. Researcher: Patrick Sherry. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University Transportation Centers Program, Research and Innovative Technology Administration, U.S. Department of Transportation. \$600,000 (2012-2014)

Mile High United Way Social Innovation Fund Early Literacy Initiative. Gloria L. Miller, PI, Amanda Moreano, Kim Hartnett-Edwards, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, \$89,992 (2012-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, \$1,000 (2012-2013)

Refugee Student Art Outreach. Researcher: Karin Dittrock-Nathan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, \$3,000 (2012-2013)

Resistance, Resilience, and Reciprocity: Centering the Voices of Black Doctoral Women with Faculty Aspirations. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, \$2,965 (2012-2013)

Assessing Learning through Student Notebooks. Research team: Keith Miller, Nancy Sasaki, and Kathy Green.

Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, \$30,000 (2012-2014)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE:

Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$2,000 (2012-2013)

ELO in Colorado. Research team: Cynthia Hazel and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-

Ellis. Colorado Legacy Foundation, \$150,000 (2012-2013)

Creating Online LIS Courses. Research team: Mary C. Stansbury (PI), Shimelis Assefa, Denise Anthony, Xiao Hu,

and Krystyna Matusiak. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, \$15,000 (2011-2013)

Maritime Piracy Seminar. Researcher: Ved Nanda, The Nanda Center, Sturm College of Law. Technical reviewer

for Sturm College of Law: Sylvia D. Hall-Ellis. Arsenault Family Foundation, \$15,000 (2012-2013).

Early Childhood Librarianship: An Interdisciplinary, Experiential Learning MLIS. Researcher: Mary C. Stansbury

(PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, \$249,066 (2012-2014)

Learning Ecosystem Planning Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis

Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, \$281,217 (2011-2012)

Advanced Service Learning Practitioner Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for

Community Engagement and Service Learning, \$400 (2011)

Evaluating and Enhancing the EspeciallyMe Program. Research team: Lori D. Patton and Nicole Russell. Technical

reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Fellowship Grant, \$24,780 (2012)

Choosing Excellence: Let Every Child Bloom. Research team: Shimelis Assefa (PI) and Mary C. Stansbury (Co-PI).

Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Grant, \$7,657 (2012)

K-8 STEM Content Specific Professional Development to Improve Elementary Student Achievement. Research team:

Kent Seidel (PI), Nicole Russell (Co-PI), Kimberly Hartnett-Edwards, Paul Michalec, Jeff Farmer, Keith Miller, Alegra Reiber, and Nancy Sasaki. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Improving Teacher Quality Grant, (Title II ESEA), \$307,299 (2011-2012)

Building a Better Principal Pipeline to Boost Student Achievement. Researcher: Susan Korach. Technical reviewer

for MCE: Sylvia D. Hall-Ellis. Denver Public Schools; a subcontract from the Wallace Foundation Grant, \$170,000 (2011-2017)

Center of Excellence for Problem Gambling. Research team: J. Mike Faragher (Co-PI) and Bobbie Vollmer (PI).

Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, \$79,999 (2011-2012)

An Exploration of Novice Teachers' Core Competencies: Impacts on Student Achievement, and Effectiveness of

Preparation. Research team: Kent Seidel (PI), Kathy Green (Co-PI), Kimberly Hartnett-Edwards, and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, Effective Teachers and Effective Teaching, \$990,987 (2012-2015)

- Project Engage, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University.* Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, \$49,964 (2011-2014)
- User-centered Evaluation of Music Search Engines.* Researcher: Xiao Hu. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, \$2,931 (2011-2012)
- Educational Practicum in Vietnam and China to Promote the Inclusion of Young Children with Disabilities.* Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, \$5,000 (2011-2012)
- Evaluation of Colorado's Enhancing Quality in Infant-Toddler (EQIT) Initiative.* Research team: Virginia R. Maloney and Amanda Moreno. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Buell Foundation, \$395,884 (2011-2013)
- Creating Engaging Environments to Teach Pre-Algebra Mathematics to Elementary Students.* Research team: Álvaro Arias, Mario López, María del Carmen Salazar, and Lyndsay Agans. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver Interdisciplinary Grant, \$60,000 (2011-2012)
- Morgridge Education Technology Accessible (META) Resource Project.* Research team: Lyndsay Agans (PI) and Shimelis Assefa (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, \$36,000 (2011)
- MCE Connect: A 21st Century Framework for Faculty Development.* Research team: Bruce Uhrmacher (PI), Shimelis Assefa (Co-PI), Lyndsay Agans (Co-PI), Kimberly Hartnett-Edwards, Norma Hafenstein, Xiao Hu, Paul Michalec (Co-PI), María del Carmen Salazar (Co-PI), and Sandra Snyder-Mondragon. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, \$22,355 (2011-2012)
- Parent Education and Parent Leadership and Advocacy.* Research team: Virginia Maloney (PI) and Amanda Moreno, Marsico Institute for Early Learning and Literacy. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, \$27,358 (2010-2011)
- Intentional School Culture.* Researcher: Cynthia Hazel. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Denver Public Schools, \$38,040 (2010-2011)
- Healthy Eaters, Lifelong Movers: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado.* Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, \$1,683,277 (2011-2014)
- Second Life Learning Community.* Research team: Don McCubbrey (PI), Sylvia D. Hall-Ellis (Co-PI), Walter LaMendola, and Paul Novak. University of Denver, Center for Teaching and Learning, \$13,000 (2010-2011)
- Reintroducing the Value of Law Librarians to Academic and Public Librarians in Colorado through the Identification and Use of Emerging Technologies.* Research team: Sylvia D. Hall-Ellis (Co-PI), Stacey L. Bowers (PI), and Christopher Hudson, in partnership with Denver Public Library, Arapahoe Library District, and the Colorado State Supreme Court Library. University of Denver, Center for Community Engagement and Service Learning, \$5,773 (2010-11)
- Reintroducing the Value of Law Librarians to Public Librarians through the Identification and Use of Emerging Technologies and Resources.* Research team: Stacey Bowers (PI) and Sylvia D. Hall-Ellis (Co-PI). American Association of Libraries, Wolters Kluwer Law & Business Grant Program, \$2,725 (2010-2011)

Faculty Service Learning Pod. Research team: María del Carmen Salazar and Nicholas Cutforth (Curriculum and Instruction Program), Frank Tuitt (Higher Education Program), Cynthia Hazel and Gloria Miller (Child, Family, and School Psychology Program), and Sylvia D. Hall-Ellis (Library and Information Science Program). University of Denver, Center for Community Engagement and Service Learning, \$8,000 (2010-2011)

Lincoln Collaborative. Research team: Antonio Esquibel (Principal, Lincoln High School), María del Carmen Salazar (Curriculum and Instruction Program), and Sylvia D. Hall-Ellis. School Improvement Grant, Denver Public Schools, \$375,000 (2010-2012)

Future LEADers of America: Leaders III. Research team: Denver Public Library (Kristen Svendsen, PI), the University of Denver (Sylvia D. Hall-Ellis), the Colorado Chapter of REFORMA (Orlando Archibeque), and the Colorado Association of Libraries (Martin Garner). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, \$988,366 (2009-2012)

Teaching for Success in the Library Environment: LIS 4030 in Library 2.0. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis (Co-PI). University of Denver, Center for Teaching and Learning, \$ 9,350 (2009-10)

Writing Group Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Community Engagement and Service Learning, \$750 (2008-2009)

Collaborative Learning Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Teaching and Learning, \$1,500 (2008)

Connecting Information Literacy to Learning. Research team: Lori Micho, Merrie Valliant, Amanda Samland, and Sylvia D. Hall-Ellis. Colorado State Library, LSTA Discretionary Grant Program, \$19,548 (2008-2009)

Law Librarianship Fellows Program. Research team: Sylvia D. Hall-Ellis (PI), Stacey Bowers (Co-PI), and Christopher Hudson, Westminster Law Library. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, \$999,370 (2008-2012)

Grant Writing in a Cooperative Learning Environment. Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, \$2,000 (2008-2009)

Project Homeless Connect 6 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, \$9,785 (2008)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, \$600 (2007)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, International Service Learning Office, University of Denver, \$400 (2007)

Project Homeless Connect 5 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, \$1,000 (2007)

Project Homeless Connect 4 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, \$4,595 (2007)

Future LEADers of America: Leaders II. Research team: Denver Public Library (Kristen Svendsen, PI), the University of Denver (Sylvia D. Hall-Ellis), and the Colorado Chapter of REFORMA (Orlando Archibeque). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, \$988,518 (2007-2010)

Strategic Planning Assistance for the Denver Medical Library. Sylvia D. Hall-Ellis. Denver Medical Library, Inc., \$30,000 (2006-2007)

Destiny Software for JMAC Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, \$10,000 (2006)

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in France. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, \$800 (2005)

Denver Public Library: Opportunities for Change. Sylvia D. Hall-Ellis, Colorado Community Based Research Network, \$2,000 (2005)

Future LEADers of America. Research team: Denver Public Library (Letty Icolari and Steve Taylor, PIs), Emporia State University (Jim Agee), and the University of Denver (Sylvia D. Hall-Ellis). Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, \$670,315 (2005-2008)

American Association of University Professors Summer Institute Professional Development Grant. Sylvia D. Hall-Ellis, American Association of University Professors, \$300 (2005)

Beta Phi Mu Alumni Tea. Sylvia D. Hall-Ellis, gift from the Office of Alumni and Parent and Relations, University of Denver, \$2,000 (2005)

Spectrum Software for LIS Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, \$5,000 (2005)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Nicholas J. Cutforth (PI) and Sylvia D. Hall-Ellis. Piton Foundation, \$25,000 (2005-2006)

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in Argentina. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, \$500 (2004)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Research team: Nicholas J. Cutforth (PI), Gary Lichtenstein and Sylvia D. Hall-Ellis, Piton Foundation, \$25,000 (2003-2004)

Increasing Spanish-Speaking and Hispanic Diversity among Library and Information Science Students at the University of Denver: Development of a Student Recruitment Model. Researcher: Sylvia D. Hall-Ellis (PI), Office of Multicultural Excellence, University of Denver, \$2,750 (2003-2004)

Collection Development Enrichment to Support the Cataloging & Classification Specialization and School Librarianship within the Library & Information Science Program at the University of Denver. Research team: Sylvia D. Hall-Ellis (PI) and Deborah S. Grealy. Women's Library Association, University of Denver, \$4,000 (2003)

Collection Development Enrichment to Support the Library & Information Science Program at the University of Denver. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis. Women's Library Association, University of Denver, \$4,000 (2001)

Wireless LAN for Library Education. Research team: Deborah S. Grealy (PI) and Sylvia Hall-Ellis. University of Denver, Center for Teaching and Learning, \$24,000 (2001-2002)

Upward Bound – A Program for South Texas Youth. Research team: Monte Churchill, Executive Director of Community Relations; Gary R. Saucedo, Outreach Coordinator; Raymond Hernandez, (PI) Associate Dean for Student Success; and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). U.S. Department of Education, Office of Postsecondary Education, \$2,672,003 (1999-2003)

Write Now! Improving Elementary Students' Writing Skills. Research team: Caryl G. Thomason, Assistant Superintendent (PI); Karen Tankersley, Principal; and, Hal Anderson, Director of Technology, Cheyenne Mountain School District 12 (Colorado Springs, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, \$189,453 (1999-2001)

Operation Quick Start -- Distance Learning in Rural Colorado. Research team: Randal Weigum, Technology Coordinator (PI); Bonnie Barns, Director of Federal Programs and Staff Development; and, Adam "Joe" Raskop, Executive Director, Southeastern Board of Cooperative Educational Services (Lamar, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, \$400,000 (1999-2001)

Advanced Technological Training for Information Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Phi Delta Kappa and the National Science Foundation, \$250,000 (1999-2001)

Working Connections – Training Information Technologies Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Microsoft Corporation and the American Association of Community Colleges, \$1,147,775(1999-2001)

The ROAD (Research Oriented Amplification of Development to Literacy) Program. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Foundation, \$25,000 (1998-1999)

Press to Literacy. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). The Denver Post and the Robert S. McCormick Foundation, \$49,818 (1998-1999)

International Telementor Center. Research team: David Neils, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Philanthropy, \$100,000 (1998-1999)

America Reads: Providing Tutor Training for the America Reads Challenge. Research team: Louis F. Cicchinelli (PI) and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, \$306,000 (1998-1999)

Comprehensive School Reform. Research team: Louis F. Cicchinelli (PI), J. Timothy Waters, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, \$285,000 (1998-1999)

Sustainable Energy Education (SEE) Program for Grades 4-8: Preparing Today's Youth for Lifelong Learning and Responsible Actions in Energy Conservation. Research team: Mary Gromko, Colorado Department of Education; Gene McCarthy, Rocky Flats Field Office, U.S. Department of Energy; Gina Kissell, National Renewable Energy Laboratory; and Barbara L. McCombs (PI), Janet L. Bishop, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). State of Colorado Governor's Office for Energy Conservation, \$499,936 (1997-1999)

Review of Kansas Curriculum Standards in Mathematics and Language Arts. Research team: Robert J. Marzano

(PI), John S. Kendall, David B. Frost, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Submitted to the Kansas State Department of Education, \$25,903 (1998)

International Telementor Center. Research team: David Neils, John Kuglin, Chris Rapp, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Company, \$54,752 (1998)

Genesis Mission: Education Public Outreach. Developed in partnership by the Jet Propulsion Laboratory, California Institute of Technology, Los Alamos National Laboratory, Lockheed Martin Astronautics, and the Mid-continent Regional Educational Laboratory (Aurora, Colorado). Research team: John T. Sutton (PI), Alice Krueger, Martha Henry, Greg Rawls, Shae Isaacs, Jeff Johnson, Deb Jordan, Arlene Mitchell, David B. Frost, Jana Caldwell, J. Timothy Waters, and Sylvia D. Hall-Ellis. National Aeronautics and Space Administration, \$139,700,000; subcontract award, \$4,750,000 (1997-2007)

North Dakota Mathematics Assessment Project. Developed in partnership by the North Dakota Department of Education and Mid-continent Regional Educational Laboratory (Mid-continent Regional Educational Laboratory). Research team: Ann Clapper, Clarence Bina, Greg Gallagher, North Dakota Department of Education; Don Burger (PI), Hillary Michaels, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, \$1,618,214; subcontract award, \$389,076 (1997-2001)

Pacific Resources for Education and Learning Distance Education: Project Evaluation. Developed in partnership by the Pacific Educational Community, the Pacific Resources for Education and Learning (PREL), and Mid-continent Regional Educational Laboratory (McREL). Research team: John W. Kofel (PI), Executive Director, PREL; J. Timothy Waters, Executive Director; Joan Buttram, Robert Keller, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, Star Schools Program, \$10,000,000; subcontract award, \$500,000 (1997-2002)

Identification of Bilingual Gifted and Talented Children: A Comprehensive School Grants for Bilingual Education. Developed in partnership by Hidalgo (Texas) ISD, Los Fresnos (Texas) CISD, Progreso (Texas) ISD, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Hilda Medrano, Dean, College of Education, University of Texas – Pan American; Linda Phemister (PI), Janie Navarro, and Sylvia D. Hall-Ellis, Education Service Center, Region One. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, \$1,670,633 (1997-2002)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Jim Hogg (Hebbronville, Texas) County ISD, Mirando City (Texas) ISD, and San Isidro (Texas) ISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg, Texas); Angie Lehmann, Amy Mares, Ellen Gonzalez (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg, Texas). Texas Education Agency, \$339,987 (1997-2000)

Southwestern Bell's Learning Communities Initiative. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen, Texas); the Center for Professional Teacher Development, University of Texas – Brownsville; Teach for America – Rio Grande Valley (McAllen, Texas); and Education Service Center, Region One (Edinburg, Texas). Research team: Patricia G. Bubb, Executive Director (PI), Tech Prep of the Rio Grande Valley; Martin Winchester, Executive Director, Teach for America – Rio Grande Valley; Aileen Johnson, Director, School of Education, University of Texas – Brownsville; and Sylvia D. Hall-Ellis. Southwestern Bell Foundation, \$100,000 (1997-1998)

Texas School to Work: Regional Implementation. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), Texas State Technical College (Harlingen), Texas Southmost College (Brownsville), Empowerment Zone of the Rio Grande Valley (Mercedes), Project VIDA (Weslaco), Youth Fair Chance (McAllen), and Education Service Center, Region One (Edinburg). Research team: Patricia G. Bubb (PI), Tech Prep of the Rio Grande Valley; Stephen Vassberg, Texas State Technical College; Ellen Trevino, Youth Fair Chance; Wanda Garza, Project VIDA; Leonardo Olivares, University of

Texas – Pan American; Michael Bell, South Texas Community College; and Sylvia D. Hall-Ellis. Texas Workforce Commission, \$4,250,000 (1997-2002).

Comprehensive Bilingual Education Grant for Hidalgo ISD and Roma ISD. Developed for Hidalgo (Texas) ISD, Roma (Texas) ISD, College of Education, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Tomas Thomas (PI), Director, Office of Bilingual Education and Sylvia D. Hall-Ellis. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, \$1,531,361 (1997-2002)

Lopez High School, Porter High School, Rivera High School, Central Middle School, and Perkins Middle School, Brownsville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$1,473,611 (1997-1998)

Donna High School, Todd Middle School, and Solis Middle School, Donna (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$704,052 (1997-1998)

Memorial Middle School and Nellie Schunior Middle School, La Joya Independent School District (Texas). Telecommunications Infrastructure Fund Board, \$293,641 (1997-1998)

Martin High School, Christen Middle School, Cigarroa Middle School, Lamar Middle School, Laredo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$1,200,000 (1997-1998).

Lasara Middle School, Lasara (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$246,210 (1997-1998)

Los Fresnos High School and Resaca Middle School, Los Fresnos (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, \$500,000 (1997-1998)

Lyford Junior High School, Lyford (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$354,997 (1997-1998)

Travis Middle School, McAllen (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$269,139 (1997-1998)

Mission High School, Mission (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$297,010 (1997-1998)

Progreso High School, Progreso (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$300,000 (1997-1998)

San Perlita High School, San Perlita (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$293,490 (1997-1998)

Myra Green Junior High School, Raymondville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$225,000 (1997-1998)

Rio Grande City High School, Ringgold Middle School, Gruella Middle School, Rio Grande City (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$809,934 (1997-1998)

Rio Hondo Junior High School, Rio Hondo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$297,024 (1997-1998)

Roma High School, Roma (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$333,178 (1997-1998)

San Benito High School, Miller Jordan Junior High School, San Benito (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, \$547,000 (1997-1998)

Santa Maria High School and Santa Maria Middle School, Santa Maria (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$400,000 (1997-1998)

Salvador High School, United Independent School District (Laredo, Texas). Telecommunications Infrastructure Fund Board, \$250,879 (1997-1998)

Weslaco High School, Cabaza Middle School, Cuellar Middle School, Weslaco (Texas) Independent School District. Telecommunications Infrastructure Fund Board, \$874,242 (1997-1998)

Principals' Assessment and Training Center. Developed for Education Service Center, Region One (Edinburg, Texas). Research team: Roberto Zamora, Leonel Barrera, William H. Parry, and Sylvia D. Hall-Ellis. Texas Principals' Leadership Initiative, Texas Association of Secondary School Principals, Texas Association of Elementary School Principals, and the Sid Richardson Foundation. \$461,439 (1996-1998)

The Texas Library Connection -- Integrating and Sharing Resources. Developed for Hidalgo County Library System (McAllen), Cameron County Library System (Brownsville), South Texas Community College (McAllen), the University of Texas - Pan American (Edinburg), University of Texas - Brownsville, and Education Service Center, Region One (Edinburg). Research team: William R. McGee, Coordinator, Hidalgo County Library System; Joe Garcia, Director, Cameron County Library System; Michael D. Bell, Library Director, South Texas Community College; Eleanor Folger Foster, University Library, University of Texas - Pan American; Jaime Vela (PI), Director of Instructional Technology and Media Services, Ron Pontius, Instructional Technology, and Fabiola Fuentes, Media Services, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Office of Library Media Services, Technology Services, Texas Education Agency. \$8,000 (1996-1997)

Developing Leadership Communities for Improving Algebra I for All Students. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Noel Villarreal (PI), Eduardo Cancino, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin. \$25,000 (1996-1997)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Edinburg (Texas) CISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg); Helen Jones, Director (PI), Gifted and Talented Education, Edinburg CISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, \$750,000 (1996-2001)

Texas Teachers Empowered for Achievement in Mathematics (TEXTEAM) Institute for Algebra I. Developed for Hidalgo ISD, Jim Hogg (Hebbronville) County ISD, La Joya ISD, La Villa ISD, Lyford ISD, Mission CISD, Pharr-San Juan-Alamo ISD, Rio Hondo ISD, San Isidro ISD, San Perlita ISD, Santa Maria ISD, Santa Rosa, Sharyland ISD, Valley View ISD, Webb (Laredo) CISD, Weslaco ISD, and Zapata County (Zapata) ISD. Research team: Noel Villarreal (PI), Chuck McInteer, Ellen M. Gonzalez, Education Service Center, Region One (Edinburg); and Sylvia D. Hall-Ellis. Charles A. Dana Center for Mathematics and Science Education, University of Texas - Austin, \$15,975 (1996)

Community Learning Center for La Villa, Texas. Developed for Edcouch-Elsa Independent School District. Research team: Noe Gonzalez (PI), Assistant Superintendent, Edcouch-Elsa Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, \$325,000 (1996-1997)

Monte Alto (Texas) Community Learning Center. Developed for Monte Alto Independent School District. Research team: Homero A. Diaz (PI), Superintendent, Monte Alto Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, \$300,000 (1996-1997)

Community Learning Center for La Villa, Texas. Developed for La Villa Independent School District. Research team: Sam Gonzalez (PI), Assistant Superintendent, La Villa Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, \$325,000 (1996-1997)

Building Project for Taylor Elementary. Developed for Mercedes (Texas) Independent School District. Research team: Mrs. Denise Rivera, Librarian, and Eduardo Infante, Principal, Taylor Elementary School; Ismael S. Cantu (PI), Federal Programs Director, Mercedes Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, \$375,000 (1996-1997)

Border Education Network (BEN) - Distance Education through Cable Television. Developed for Edinburg (Texas) Consolidated Independent School District. Research team: Noe Torres (PI), Library Media Specialist, Magdalena Rosas, Library Media and Technology Coordinator, Edinburg Consolidated Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Edinburg (Texas) Consolidated School District, \$250,000 (1996-1997)

Multiservice One-Stop Open Enrollment Charter School. Developed for the Information Referral Resource Assistance, Inc. (McAllen, Texas). Research team: Pablo Perez and Aguié Pena (PI), Executive Director, Information Referral Resource Assistance, Inc.; Roberto Zamora and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, \$3,066,000 (1996-2001)

Project OK: A Community Youth Opportunities Grant for Summer, 1996. Developed for McAllen (Texas) Independent School District, St. Joseph the Worker Catholic Church, and the Office of Adult Education, Education Service Center, Region One. Research team: Father Bart Flatt, St. Joseph the Worker Catholic Church; Noe Calvillo (PI), Office of Adult Education; Maria Louisa Garcia, McAllen Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Protective and Regulatory Agency through the Office of the Mayor, City of McAllen, \$350,000 (1996-2001).

Early Childhood: a Time of Discovery. Developed for a partnership of Lasara ISD, Rio Hondo ISD, San Perlita ISD, the School of Education, University of Texas - Brownsville, and Education Service Center, Region One (Edinburg). Research team: Hugo Rodriguez, Dean, School of Education, University of Texas - Pan American; Leonel Barrera and Jack Damron, Field Service Agents, Ellen M. Gonzalez (PI), Administrator for Student Instructional Services, Ruth Solis, Education Specialist in Special Education, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, \$722,090 (1996-2001)

Innovative Gifted and Talented Programs for Early Childhood and Elementary Education Students. Developed for a partnership of Edinburg (Texas) CISD, the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Helen de la Garza (PI), Director of Elementary Curriculum and Instruction, Edinburg CISD; and Sylvia D. Hall-Ellis. Texas Education Agency, \$750,000 (1996-2001)

Reading Recovery in Early Elementary Grades. Developed for a partnership of La Villa (Texas) ISD the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Marcario Salinas (PI), Supervisor of Elementary Curriculum and Instruction, La Villa ISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One. Texas Education Agency, \$750,000 (1996-2001)

Connected Mathematics Project for Middle and Junior High Students. Developed for a partnership of Michigan State University, The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin and Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). National Science Foundation through Michigan State University to the Charles A. Dana Center at the University of Texas - Austin, \$539,610 (1996-1999)

Sharing Resources: Testing the Interlibrary Loan Potential of the Texas Library Connection -- Integrating Media Resources. Developed under the sponsorship of the Hidalgo County Library System (McAllen) and Education Service Center, Region One (Edinburg). Research team: William H. McGee, Hidalgo County System Coordinator; Fabiola Fuentes, Library Media; Ronald Pontius (PI), Instructional Technology, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Library Media Services Program, Office of Technology Services, Texas Education Agency, \$25,000 (1996-1997)

State and Federal Adult Education JOBS Program. Developed for Education Service Center, Region One (Edinburg). Research team: Noe Calvillo (PI), Director, Adult Education Program, and Sylvia D. Hall-Ellis. Adult Education Program, Texas Education Agency, \$532,846 (1995-1996)

Creating Safe and Drug-Free Schools and Communities. Developed for a partnership of the Region One Consortium for Safe and Drug-Free Education Environments. Research team: Clara Contreras (PI), Health Specialist, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, \$150,000 (1995-1996)

Developing Leadership Communities for Improving Mathematics Performance for All Students on Title I Campuses. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin, \$50,669 (1995-1996)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Texas Association of School Librarians, Children's Services Round Table, and Young Adults Round Table (Austin, Texas), \$2,500 (1995)

School Library Media Specialists Fellowship Program. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville, Texas). U.S. Department of Education, HEA Title II-B, Library Education and Human Resource Development Program, \$44,000 (1995-1996)

Planning for Educational Technology. Research team: Ruth Ann Riggins (PI), Director of Library Media and Technology Services, Donna (Texas) Independent School District; Noe Torres, Education Service Center, Region One; Patricia G. Bubb, Tech Prep of the Rio Grande Valley, Inc; Michael D. Bell, South Texas Community College; and Sylvia D. Hall-Ellis, Sam Houston State University. Developed under the sponsorship of Donna (Texas) Independent School District, Education Service Center, Region One (Edinburg), Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), and the Department of Library Science, Sam Houston State University (Huntsville). Funded through Infusion of Educational Technology Planning Grant Program (H.B. 18: Models). Texas Education Agency, \$18,000 (1993-1994)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas.

Sylvia D. Hall-Ellis (PI) and Mary Ann Berry. Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Sam Houston State University Research Enhancement Fund, \$7,500 (1993-1994)

Electronic Mail Resource Sharing System: Management and Operation of the Iowa Computer-Assisted Network. State Library of Iowa, \$294,000 (1986-1993)

The Iowa Locator: A CD-ROM Resource Sharing Tool. State Library of Iowa, \$567,000 (1986-1992)

Statewide Database Development: An OCLC Tape Analysis To Determine Feasibility. State Library of South Dakota, \$15,000 (1987)

The Iowa Locator: A Feasibility Study. State Library of Iowa, \$50,000 (1986)

Electronic Mail Resource Sharing System: A Feasibility Study for Libraries in the State of Iowa. State Library of Iowa, \$5,000 (1985)

Access Pennsylvania: A Feasibility Study. State Library of Pennsylvania, \$50,000 (1984)

Automating Library Administrative and Management Tasks: Procurement and Distribution of Microcomputer Systems for District Library Centers in the Commonwealth of Pennsylvania. State Library of Pennsylvania, \$495,000 (1982)

Sharing Serial Titles Resources: Procurement and Distribution of Microfiche Readers for 550 Libraries in the Commonwealth of Pennsylvania. State Library of Pennsylvania, \$500,000 (1982)

Electronic Mail System: A Pilot Project for Libraries throughout the Commonwealth of Pennsylvania. State Library of Pennsylvania, \$125,000 (1982)

Literacy Program for Adults in Rural Upstate New York State: Program Outreach and Evaluation - Phase 3. Appalachian Regional Commission, \$50,000 (1981)

Database Building: A Cooperative Project of the Finger Lakes Library System (Ithaca), Four County Library System (Binghamton), and the Southern Tier Library System (Corning). New York State Library, \$450,000 (1980-1985)

Faces of the Southern Tier: A Professional Photographer-in-Residence. New York State National Endowment for the Humanities, \$25,000 (1980)

Literacy Program for Adults in Rural Upstate New York State: Program Implementation - Phase 2. Appalachian Regional Commission, \$50,000 (1980)

Small Business Resources Center: A Pilot Project for Rural Public Libraries. New York State Library, \$50,000 (1980)

Media Programming: A Professional Development Program for Public Librarians in Upstate New York: A Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, \$35,000 (1979)

Information and Library Resources for Inmates and Prisoners in Selected Upstate New York Facilities: A Cooperative Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, \$25,000 (1979)

Library Resources for Homebound Adults in Upstate New York: An Outreach Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, \$40,000 (1979)

Literacy Program for Adults in Rural Upstate New York State: Program Initiation and Establishment - Phase 1. Funded by the Appalachian Regional Commission. Awarded to the Corning (New York) Public Library, \$50,000 (1979)

Information Reference Services to Homebound Adults. New York State Library, \$31,000 (1978)

Books-By-Mail Services to Homebound Adults. New York State Library, \$31,000 (1978)

System Headquarters Services and Programs for Public Libraries in District 10. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, \$880,000 (1976)

County Library Development Grant for Atascosita County. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, \$15,000 (1976)

Spanish Language Materials Collection Development Program. Texas State Library and Historical Commission, \$40,000 (1975)

Establishment of System Headquarters for Alamo Regional Library System (District 10) Headquartered at the San Antonio (Texas) Public Library. Texas State Library and Historical Commission, \$800,000 (1975)

SELECTED CONSULTANTSHIPS

Project Strategic Planning & Funding Proposal Development

Walden University, 2015.

Pikes Peak Library District, 2014.

Douglas County Public Libraries, 2011-2012.

Denver School for Science and Technology, 2008-2011.

Johnson & Wales University, Denver Campus, 2007-2009.

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Bemis Public Library (Littleton), Ergonomic Design and Facilities Enhancement Consultant, 2003.

Curtis Park Community Center (Denver), Community Technology Center Evaluation and Proposal Development Consultant, 2003.

Colorado Community Based Research Network (Denver), Funding Research Associate, 2002.

Our Lady of the Rosary Academy (Edgewater), Learning Resource Center Development Project Consultant, 2001-2003

University of Southern Colorado (Pueblo). Technology Integration and Curriculum Enhancement into Higher Education Learning Environment. Proposal Development Consultant, 2000.

Jefferson County Library System (Lakewood), 1999-2000.

Southeastern BOCES (Lamar, CO). Distance Learning Curriculum Content Development Project. Proposal Development Consultant, 1998-2004.

Cheyenne Mountain School District 12 (Colorado Springs, CO). Technology Integration into Elementary Writing Curriculum Project. Proposal Development Consultant, 1998.

Telecommunications Infrastructure Fund Board Round #2 Application, 1997. Technical assistance to the following: La Villa (Texas) Independent School District; Mirando City (Texas) Independent School District; Monte Alto (Texas) Independent School District; San Isidro (Texas) Independent School District.

Telecommunications Infrastructure Fund Board Round #1, 1996. Technical assistance to the following: Brownsville (Texas) Independent School District; Donna (Texas) Independent School District; Edinburg (Texas) Consolidated Independent School District; Harlingen (Texas) Consolidated Independent School District; Jim Hogg County Independent School District (Hebbronville, Texas); La Feria (Texas) Independent School District;

La Joya (Texas) Independent School District; La Villa (Texas) Independent School District; Los Fresnos (Texas) Consolidated Independent School District; Progreso (Texas) Independent School District; Raymondville (Texas) Independent School District; Rio Hondo (Texas) Independent School District; San Benito (Texas) Independent School District; Sharyland Independent School District (Mission, Texas); Weslaco (Texas) Independent School District; Zapata (Texas) County Independent School District.

South Texas Community College (McAllen). Strategy Development to Meet the Technology Instructional Needs for Vocational, School-To-Work and Academic Programs, 1994-2000. Development Consultant.

Donna (Texas) Independent School District. Planning for the Infusion of Technology in Middle Schools Serving High At-Risk Students, 1994-1995. Research Associate.

Pettus (Texas) Independent School District. Planning for District-wide Automation in School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994. Principal Investigator.

Fort Bend Independent School District (Sugar Land, TX). Planning for District-wide Automation in School Library Media Centers, Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994-1995. Principal Investigator.

Northern Waters Library Services (Ashland, WI). Professional Consulting Services to Make Recommendations on the Development of System-Wide Efforts of the Northern Waters Library Service, 1988-1989. Research Associate.

State Library of Iowa (Des Moines). The Iowa Locator Compact Disc to Support Multi-Type Libraries Resource Sharing including Database Design, Building, Production, and Distribution, 1986-1991. Project Director.

State Library of Iowa (Des Moines). Iowa Computer-Assisted Network Development, Enhancement, and Operation, 1985-1992. Technical Director.

State Library of South Dakota (Pierre). Statistical Sampling and Analysis of Multi-Institutional OCLC Archive Tape for Statewide Online Database Building, 1985-1986. Research Associate.

District of Columbia Public Library (Washington, DC). Planning Document for the Retrospective Conversion of Bibliographic Records and Automation Issues in the 1990's, 1984-1985. Research Associate.

State Library of Pennsylvania (Harrisburg). Database Development for High School Libraries, 1984-1985. Research Associate.

MINITEX (Minneapolis, MN). Workshops for Retrospective Conversion, Bar Coding, Library Statistics, and OCLC Serials Format, 1985. Presenter and Research Associate.

ABC Film Consortium (Altoona, Bellefonte, Johnstown, PA). Database Building, System Design, and Implementation of Online Film Booking System, 1983-1985. Database Manager.

Library Automation -- System Design & Implementation

Douglas County Library District (Castle Rock, CO). Library Automation Technical and System Performance Specifications, 2001.

Pharr-San Juan-Alamo Independent School District (Pharr, TX). Library Automation Technical and System Performance Specifications, 1997. Project Development Consultant.

Harlingen (Texas) Independent School District. Planning for District-wide Automation in Junior High School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1996. Principal Investigator.

Sharyland (Texas) Independent School District. Design and Construction of New Elementary School Library and Technology Resources Center, 1995-1996. Principal Investigator.

South Texas Independent School District (Mercedes, TX). Design and Construction of a New High School Library and Technology Resources Center, 1995-1996. Principal Investigator.

Citizens' Library (Washington, PA). Online Community Resources Files: Design and Implementation, 1984. Research Associate.

Altoona (Pennsylvania) Hospital. Integrated Online System Upgrade Study, 1984. Research Associate.

State Library of South Dakota (Pierre). Automation Plan and State Database Development, 1982-1983. Principal Investigator.

State Library of Pennsylvania (Harrisburg). COM Production and Preparation of the Technical Specifications Document, Procurement, and Distribution of Microcomputers in the Commonwealth of Pennsylvania, 1983-1984. Research Associate.

Altoona (Pennsylvania) Area Public Library. Integrated System (Circulation/Online Catalog) Study, 1982-1983. Principal Investigator.

COPSCAULD (Council of Pennsylvania State College and University Library Directors, Edinboro, PA). Design of Online Media Catalog, 1982. Principal Investigator.

Erie (Pennsylvania) County Library System. Operations Research and Design for Automated Circulation, Hardware Upgrade and Re-Retrospective Conversion, 1982. Research Associate.

Michigan Library Consortium (Lansing, MI). Tape Management System Design and Implementation, 1982-1984. Research Associate.

State Library of Pennsylvania (Harrisburg). Preparation of the Technical Specifications Document, Procurement and Distribution of Microfiche Readers in the Commonwealth of Pennsylvania, 1982. Research Associate.

Community College of Allegheny County, Allegheny Campus (Pittsburgh, PA). Integrated Systems Study, 1981. Principal Investigator.

Community College of Allegheny County, South Campus (West Mifflin, PA). Retrospective Conversion Training Program for Handicapped Students, 1981. Technical Director.

Southern Tier Library System (Corning, NY). OCLC Acquisitions Subsystem Evaluation, 1981. Principal Investigator.

South Central Reference and Research Council (Ithaca, NY). South Central Regional Delivery System, 1980. Principal Investigator.

Southern Tier Library System (Corning, NY). Newspapers on Microfilm in the Chemung-Southern Tier Library System, 1979-1981. Principal Investigator.

Cataloging & Bibliographic Database Building

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Ricks Gifted and Talented School Library, 2005-

American Humane Society (Englewood), 2004-2006.

Fisher Early Learning Center Library, 2004-

Colorado Community Based Research Network (Denver), 2004-

Boulder Valley School District (Boulder), 2002-2003.

Douglas Public Library District (Castle Rock), 2001-2002.

Bibliographic Center for Research, Inc. (Denver). Original Cataloging, 2001-2003 & 1992-1993. Professional Cataloger. Libraries include Arapahoe Library District (Centennial); Clarke College (Clarke, IA); Kaiser Permanente Center for Health Research (Portland, KS); Douglas County Library System (Carson City, NV); Grinnell College (Grinnell, IA); Kansas State University (Manhattan, KS); Kansas State Library (Topeka, KS); McPherson College (McPherson, KS); Newman University (Wichita, KS); Montana Technical University (Helena, MT); Montana State Library (Helena, MT); University of Texas Southwest Medical Center Library (Dallas, TX); Community College of Southern Nevada (Las Vegas, NV); Pikes Peak Library District (Colorado Springs); Mesa Community College (Grand Junction); Coe College (Cedar Rapids, IA); Briar Cliff College (Sioux City, IA); Tri-Care Health Systems (Aurora); The Penrose-St. Francis Healthcare System (Colorado Springs); Westminster Public Library (Westminster); Lutheran Medical Center Medical Library (Wheat Ridge); American Heritage Center, University of Wyoming (Laramie, WY); National Wildlife Research Center Library (Lakewood); University of Colorado Health Sciences Center, Denison Memorial Library (Denver); Water Resources Library, Denver District Office, Bureau of Land Management (Lakewood); Mesa State Community College Learning Resources Center (Pueblo); Front Range Community College Learning Resources Center (Westminster).

Colorado Historical Society Library (Denver). Original Cataloging of Serials for Multi-Institutional Union Listing Project, 1993. Technical Services Associate. Institutional partners: Denver Art Museum, Denver Museum of Natural History Library, and Denver Botanical Gardens Library.

Arapahoe Library District (Centennial). Original Cataloging of Major Media, 1991.

Original Cataloging Projects: Davis and Elkins College (Elkins, WV), 1989-1990; Waldorf College (Forest City, IA), 1989-1990; Kennametal Corporation (Latrobe, PA), 1984-1985; Pennsylvania Public Libraries Film Center (Harrisburg), 1982-1985.

Retrospective Conversion Projects: North Central Regional Library Service (Mason City, IA), 1987-1988; Southeastern Library Services (Davenport, IA), 1986-1987; Virginia Theological Seminary (Alexandria), 1984-1985; California University of Pennsylvania (California, PA), 1984-1985; Kennametal Corporation (Latrobe, PA), 1984-1985; West Virginia University (Morgantown), 1983-1985; Altoona Area Public Library (Altoona, PA), 1983-1984; George Washington University (Washington, DC), 1983-1984; Indiana University of Pennsylvania (Indiana, PA), 1983-1985; Health Education Center (Pittsburgh), 1983-1984; Central Pennsylvania District Library Center (Bellefonte, PA), 1982-1985; Duquesne University Law School Library (Pittsburgh), 1982-1983; Allegheny County Law Library (Pittsburgh), 1982-1984; Calgon Technical Information Center (Pittsburgh), 1982; Dow Corning Corporation, Technical Information Center (Midland, MI), 1982-1983; Tri-System Public Library Retrospective Conversion Project (Binghamton, Corning, and Ithaca, NY), 1978-1981, Technical Project Director.

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