

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 10,075,941)
Issued: Sep. 11, 2018)
Application No.: 15/082,878)
Filing Date: Mar. 28, 2016)

For: **Methods And Apparatus For Multi-Carrier Communication Systems
With Adaptive Transmission And Feedback**

DECLARATION OF INGRID HSIEH-YEE, PH.D.

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I. Introduction

I, Ingrid Hsieh-Yee, Ph.D., do hereby declare as follows:

1. I have personal knowledge of all of the matters about which I testify in this declaration.

2. I have been retained as an independent expert witness on behalf of Ford Motor Company (“FORD”) for proceedings before the United States Patent and Trademark Office (“PTO”) regarding the authenticity and public availability of certain prior art references in relation to US Patent No. 10,075,941 (“the ’941 patent”).

3. I am being compensated for my work in this matter at my customary hourly rate. I am also being reimbursed for any reasonable expenses associated with my work and testimony in this investigation. My compensation is not contingent on the results of my study, the substance of my opinions, or the outcome of this matter.

A. Qualifications and Professional Experience

4. My complete qualifications and professional experience are described in my academic curriculum vitae (**Appendix A**). The following is a brief summary of my relevant qualifications and professional experience.

5. In 2022 I was conferred the title of Professor Emerita after 32 years as a professor in the Department of Library and Information Science of the Catholic University of America. I have experience working in an academic library, a medical

library, and a legislative library. I hold a Ph.D. in Library and Information Studies from the University of Wisconsin-Madison and a Masters in Library and Information Studies from the University of Wisconsin-Madison.

6. I am an expert on library cataloging and classification and have published two editions on this subject, *Organizing Audiovisual and Electronic Resources for Access: A Cataloging Guide* (2000 and 2006). I taught a variety of courses, including Cataloging and Classification, Advanced Cataloging and Classification, Organization of Internet Resources, Organization of Information, Digital Content Creation and Management, Metadata, Internet Searches and Web Design, Information Literacy Instruction, Advanced Information Retrieval and Analysis Strategies, and The Information Professions in Society. I am familiar with metadata schema design and implementation. In my teaching I covered the design and implementation of metadata in libraries, databases, search engines, digital repositories, digital libraries, and digital archives. I also covered how the ways we organize information resources affect the discovery and access to digital resources on the Internet. My research interests cover cataloging and classification, information organization, metadata, information retrieval, information architecture, digital collections, scholarly communication, social media, user interaction with information systems, and others.

7. I am very familiar with a library cataloging encoding standard known as the “Machine-Readable Cataloging” standard, also known as “MARC,” which became the national standard for sharing bibliographic data in the United States by 1971 and the international standard by 1973. MARC is the primary communications protocol for the transfer and storage of bibliographic metadata in libraries. Experts in my field reasonably rely upon MARC records when forming their opinions.

8. A MARC record consists of 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 follows. **Appendix B** is a true and correct copy of Parts VII to X of “Understanding MARC Bibliographic: Machine-Readable Cataloging” (<http://www.loc.gov/marc/umb/um07to10.html>) from Library of Congress. *Understanding MARC Bibliographic* was originally published by the Follett Software Co. and copyrighted in 1988. Editions in 1989, 1990, 1994, 1998, 2000, 2003 and 2009 include changes. The latest edition was copyrighted in 2009. This document explains commonly-used MARC fields. For example, the personal author of the work is recorded in Field 100, the title is recorded in Field 245, publisher information is recorded in Field 260, the physical volume and characteristics of a publication are recorded in Field 300, and topical subjects are recorded in the 650 fields.

9. The Online Computer Library Center (OCLC) is the largest bibliographic network of the world, with more than 554 million records and thousands of member institutions (many of which are libraries of some type) in more than 100 countries. OCLC was founded in 1967 to promote and support library cooperation. According to the “Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Inc.,” 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” (source: <https://www.oclc.org/content/dam/oclc/membership/articles-of-incorporation.pdf>).

10. OCLC members can contribute original cataloging records in MARC to the system or derive cataloging records from existing records, an activity referred to as “copy cataloging.” When an OCLC participating institution acquires a work, it can create an original MARC record for the work in OCLC’s Connexion system (a system for catalogers to create and share MARC records), and the system will automatically generate a code for the date of record creation in the yymmdd format,

and the creating library's OCLC symbol is recorded in subfield "a" of the 040 field. Once the MARC record is in Connexion, it becomes available to other OCLC members for adoption to their local online catalogs (*i.e.*, copy cataloging).

11. After a MARC record is created in Connexion, it also becomes searchable and viewable on WorldCat, which is a free web portal for users to explore the collections of more than 10,000 libraries worldwide. The record in WorldCat, however, is not presented in MARC fields. Instead, the data elements are labeled to help users interpret the record. Thus, the information stored in MARC records in Connexion is available to the interested public through the free and user-friendly WorldCat web portal.

12. WorldCat (<http://www.worldcat.org>) is "the world's largest network of library content and services" and its features are summarized in "about WorldCat" (<https://www.worldcat.org/about>). WorldCat began operation in January 1998 as a free web portal to more than 10,000 library collections worldwide. Through WorldCat, users can search for information resources in their local libraries and libraries around the world. WorldCat allows users to search for books, CDs, videos, and many new types of digital content, such as audiobooks, in many languages. Users can also retrieve research materials and article citations with links to their full text. After an item is retrieved, WorldCat helps users identify a library nearby that holds the item or all the libraries that hold the item. WorldCat is an efficient way to

explore library collections on the Internet. WorldCat is publicly accessible, and there is no fee to perform searches on WorldCat.

13. Library online catalogs gained acceptance in the early 1980s and many libraries migrated their systems to the World Wide Web in the mid-1990s. Library online catalogs are based on MARC records that represent their collections in order to help the public understand what materials are publicly accessible in those libraries. Most libraries with online catalogs have made their catalogs freely available on the Web. These online catalogs offer user-friendly search interfaces. Strong user interest in keyword searches and the popularity of Google have led to the “googlization” of library search systems. As a result, many library catalogs now provide a single search box for users to conduct keyword searches, with additional support for searches by author, title, subject terms, and other data elements such as ISBN (International Standard Book Number). Library catalogs these days also offer features for users to narrow their search results by language, year, format, and other elements. Many libraries display MARC records on their online catalogs with labels for the data elements to help the public interpret MARC records. Many libraries also offer the option to display MARC records in MARC fields.

14. Libraries create MARC records for works they acquire to facilitate the discovery and access to works in their collections, which may include books, serials, motion pictures, and publications in other formats. Monograph cataloging is fairly

common in libraries, and most libraries make a newly cataloged monograph available to the public soon after the cataloging work is completed, usually within a week. Libraries can create original cataloging records or use an existing record in OCLC to create a copy cataloging record. As soon as the cataloging record is completed, it is added to the library's online catalog for users. If the record is an original record, it is also entered into the OCLC system. If it is a copy cataloging record, the library's holding symbol is attached to the existing original record in the OCLC system to facilitate searching and interlibrary loan.

15. Conference proceedings can be cataloged as monographs or serials, depending on a library's policy. Libraries usually choose to catalog conference proceedings as monographs because records for monographs are easier for users to discover and understand, and access to individual conference proceedings becomes easier. Once a record for a conference proceedings is found, users can see the title, conference name, subjects, and related contributors clearly identified in the record and the call number will enable users to access the desired title quickly. Conference proceedings cataloged as monographs are treated as regular monographs, and the newly cataloged monographs typically become publicly accessible soon after the cataloging work is completed, usually within a week.

16. I am personally familiar with many online catalogs, databases, and search engines. In preparing for this declaration, I used the following authoritative information systems to search for records:

- Google Scholar (<https://scholar.google.com>)
- Online catalog of the library of the US Naval Academy (<https://www.usna.edu/Library/>)
- Online catalog of the Linda Hall Library (<https://catalog.lindahall.org/>)
- Public catalog of the US Copyright Office (<https://cocatalog.loc.gov/cgi-bin/Pwebrecon.cgi?DB=local&PAGE=First>)
- WorldCat (free for public access on the Web) (<https://www.worldcat.org>)

B. Scope of This Declaration

17. I have been asked to offer an opinion on the authenticity and public availability date of the following document:

Tufvesson, F., & Maseng, T., (1997, May), "Pilot assisted channel estimation for OFDM in mobile cellular systems," in the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion*, vol. 3, pp. 1639-1643, **Ex. 1010** ("Tufvesson").

18. I am rendering my expert opinion on the authenticity of the documents referenced herein and on whether they were published. I will provide my opinion on when and how these documents were publicly disseminated or otherwise made

publicly available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, could have located and retrieved these documents.

19. I am informed by counsel that an item is considered authentic if there is sufficient evidence to support a finding that the item is what it is claimed to be. I am also informed that authenticity can be established based on the contents of the documents themselves, such as the appearance, content, substance, internal patterns, protocols followed or other distinctive characteristics of the item.

20. I am informed by counsel that a given reference is “published” if it is publicly accessible upon a satisfactory showing that such a document has been disseminated or otherwise made publicly available to the extent that persons interested and ordinarily skilled in the subject matter or art could locate it exercising reasonable diligence and obtain the document. I have also been informed by counsel that materials available in a library constitute “printed publications” if they are cataloged and indexed according to general library practices and protocols that make the references available and accessible to members of the interested public.

21. I have been informed by counsel that the ’941 patent was filed in the United States on March 28, 2016 and that Patent Owner alleges that the ’941 patent is entitled to a priority date of no later than February 13, 2004. I have assessed public accessibility of the documents referenced below as of this date.

C. Person of Ordinary Skills in the Arts

22. I am told by counsel that the subject matter of this proceeding relates to wireless communication systems.

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

24. I am told by counsel that a person of ordinary skill in this subject matter or art in the early 2004 timeframe would have had a bachelor’s degree in electrical engineering, computer engineering, computer science, or an equivalent field, or an advanced degree in those fields, as well as at least 3-5 years of academic or industry experience in mobile wireless communications, or comparable industry experience.

25. It is my opinion that such a person would have been actively engaged in learning about the field, possibly through formal instruction through the bibliographic resources. By at least early 2004 such a person would have had access to a vast array of print and electronic resources, including at least the documents referenced below.

D. Evidence Considered in Forming My Opinions

26. In the preparation of this declaration, I have reviewed the documents referenced below and any other documents I reference herein, and each of these is a type of material that experts in my field would reasonably rely upon when forming their opinions:

- (1) The document referenced above in Section I.B;
- (2) IEEE metadata record for *Tufvesson*, available at <https://ieeexplore.ieee.org/document/605836>, and front matter of the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion*, available at <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=605391> from IEEE Xplore, accessed and obtained on March 18, 2023, **Appendix 1010A**;
- (3) Copyright registration record for 1997 IEEE 47th vehicular technology conference, Phoenix, Arizona, USA, May 4-7, 1997 : technology in motion that contains *Tufvesson*, available at https://cocatalog.loc.gov/cgi-bin/Pwebrecon.cgi?Search_Arg=1997+IEEE+47th+Vehicular+Technology+Conference&Search_Code=TALL&PID=c9R4HBBa5H4MZqdh91zq0Dzzp0eY5&SEQ=20230318124125&CNT=25&HIS T=1, accessed and obtained on March 18, 2023, **Appendix 1010B**;
- (4) Bibliographic and MARC records for the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion* that contains *Tufvesson*, available at

https://usna.primo.exlibrisgroup.com/permalink/01USNA_INST/1dcrln8/alma991002436939706751 from the online catalog of the US Naval Academy Library, accessed and obtained on March 21, 2023, **Appendix 1010C**;

- (5) Bibliographic and MARC records for the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion* that contains *Tufvesson*, available at https://catalog.lindahall.org/permalink/01LINDAHALL_INST/191da7s/alma992744933405961 from the online catalog of Linda Hall Library, accessed and obtained on March 25, 2023, **Appendix 1010D**;
- (6) Citations to *Tufvesson*, obtained from Google Scholar, **Appendix 1010E**.

II. Authentication and Public Availability of *Tufvesson* (Ex. 1010)

A. Authentication

27. **Ex. 1010** is a true and correct copy of “Pilot assisted channel estimation for OFDM in mobile cellular systems,” (“*Tufvesson*”), by F. Tufvesson and T. Maseng, in the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion*, vol. 3, pp. 1639-1643, that I obtained from the Institute of Electrical and Electronics. When I began preparing this declaration I searched Google Scholar for records for *Tufvesson*, and the link from the retrieved record led me to the IEEE metadata record for this article in the IEEE Xplore Digital Library. I then used the

PDF link to purchase this article from the publisher. This IEEE copy is presented as **Ex. 1010** in this declaration.

28. **Ex. 1010** is a true and correct copy of *Tufvesson* that I obtained from IEEE Xplore, the digital library created and maintained by the Institute of Electrical and Electronics Engineers. Page 1 (internal page 1639) shows the title, authors, and abstract of this article. The bottom of this page shows the article appears in a publication with an ISBN (International Standard Book Number) of “0-7803-3659-3” and has a “1997” copyright date with the IEEE as the copyright holder. **Ex. 1010** shows *Tufvesson* has a total of five pages, including 20 equations, 11 figures, and eight references.

29. The IEEE copy of *Tufvesson* (**Ex. 1010**) is in a condition that creates no suspicion about its authenticity. Specifically, this copy is not missing any intermediate pages, the text on each page appears to flow seamlessly from one page to the next, and there are no visible alterations to the document. Moreover, **Ex. 1010** was found in the custody of a digital library owned and managed by the publisher, a place where, if authentic, it would likely be found. Accordingly, I see no reason to question the authenticity of the IEEE copy of *Tufvesson* (**Ex. 1010**).

B. IEEE Database Record for *Tufvesson*

30. **Appendix 1010A** is a true and correct copy of the metadata record for *Tufvesson* obtained from the IEEE Xplore Digital Library. I personally located,

identified, and obtained this record. This is the type of record experts in my field would reasonably rely upon when forming their opinions.

31. Page 1 of **Appendix 1010A** shows the title and authors of the *Tufvesson* article. It also shows IEEE as the publisher, and indicates *Tufvesson* has 75 paper citations, 93 patent citations, and 1226 full text views. The abstract in this record is identical to the abstract in the IEEE copy (**Ex. 1010**). Page 2 of the IEEE metadata record shows *Tufvesson* was published in the “1997 IEEE 47th Vehicular Technology Conference. Technology in Motion,” the conference date is “04-07 May 1997” and the conference location is “Phoenix, AZ, USA.” The record shows the article DOI (digital object identifier) is “10.1109/VETEC.1997.605836” and the “Date Added to IEEE Xplore” field shows this metadata record was added to this digital library on “06 August 2002.” The record also shows the conference proceedings has an ISBN of “0-7803-3659-3”. The title, authors, abstract, and ISBN in this record match the information contained in the publisher’s copy (**Ex. 1010**), confirming this record represents *Tufvesson*.

32. The IEEE metadata record for *Tufvesson* includes a direct link to the conference, and the link leads to an IEEE record for this conference (available at <https://ieeexplore.ieee.org/xpl/conhome/4664/proceeding>). A screen capture of the top of this record is included as page 3 in **Appendix 1010A**. The front matter of this conference is freely available to the public at

<https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=605391>, and is included in **Appendix 1010A** as pages 4 to 32.

33. Page 4 of **Appendix 1010A** is the title page of the conference proceedings. It shows the name, location and date of the conference and also shows “Technology in Motion” as the conference theme. Page 5 (internal page ii) is the copyright page that shows the proceedings has a “1997” copyright date and the Institute of Electrical and Electronics Engineers, Inc. is the copyright holder. This page also shows 97CH36003 (softbound) and 97CB36003 (casebound) as the IEEE catalog numbers, 0-7803-3659-3 (softbound), 0-7803-3660-7 (casebound), 0-7803-3661-5 (microfiche) and 0-7803-4075-2 (CD-ROM) as the ISBNs, and 1090-3038 as the ISSN (International Standard Serial Number) for the conference proceedings. This page also shows the publisher’s operations center is located at Piscataway, NJ. Pages 7 to 32 (internal page iv to xxix) are the table of contents and page 27 (internal page xxiv) shows *Tufvesson* is included in the “WF2 OFDM I” section and identified as WF2.3, running from pages 1639 to 1643.

34. Data in the IEEE metadata record for *Tufvesson* and the front matter of the print version of the conference proceedings containing *Tufvesson* inform my opinion that *Tufvesson* was published in 1997, and IEEE Xplore indexed the article and added the metadata record into the IEEE Xplore Digital Library on August 6, 2002. The IEEE record made *Tufvesson* discoverable in the IEEE Xplore system

from that date on. Interested users in August 2002 would have been able to locate the metadata record for *Tufvesson* and purchase the article from IEEE or obtain it from an institution that subscribed to IEEE Xplore Digital Library.

C. Copyright Registration Record

35. **Appendix 1010B** is a true and correct copy of the copyright registration record for *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion* that contains *Tufvesson*. I obtained this record from the public catalog of the U.S. Copyright Office by first accessing their website at <http://www.copyright.gov/>, selecting the “Learn More” link under “Search Copyright Records,” and following the link for “Official Public Catalog (1978 to present)” under “Online Records Collections” to perform a title search to retrieve the record. I personally located, identified and obtained this record. This is the type of record experts in my field would reasonably rely upon when forming their opinions.

36. The “Type of Work” field identifies the publication as “Text.” The title, imprint, and copyright claimant information match the information presented in the front matter of this conference proceedings included in **Appendix 1010A**. The “Date of Creation” field shows this work was created in 1997, and the “Date of Publication” field shows “1997-05-05” (*i.e.*, May 5, 1997). The “Registration Number / Date” field shows “TX0004583430 / 1997-06-18” indicating this conference proceedings was registered with the Copyright Office on June 18, 1997.

This record informs my opinion that the conference proceedings containing *Tufvesson* was published on May 5, 1997, and registered with the U.S. Copyright Office on June 18, 1997.

D. Library Records from the US Naval Academy Library

37. To determine the availability of *Tufvesson* in libraries, I searched by “1997 IEEE 47th Vehicular Technology Conference : technology in motion, Phoenix, Arizona, USA, May 4-7, 1997” in WorldCat for records, and found a record at <https://www.worldcat.org/title/37309457> that shows the library of the US Naval Academy is one of the holdings libraries of this proceedings, so I searched their online catalog for records, and the search results confirmed the holdings information. **Appendix 1010C** is a true and correct copy of the records obtained from this library. I personally located, identified, and obtained these records. They are the type of record experts in my field would reasonably rely upon when forming their opinions.

38. Pages 1 and 2 of **Appendix 1010C** are the bibliographic record that identifies this work as a “conference proceeding,” shows the title as “1997 IEEE 47th Vehicular Technology Conference : technology in motion, Phoenix, Arizona, USA, May 4-7, 1997” and indicates this work is available at “NIMITZ Library Third Floor General Stacks (TK6570.M6 I22 1997).” The “Location Items” area shows this proceedings has three volumes and all of them are “loanable” (meaning users can access these volumes). The detailed record on page 2 shows the title, ISBNs,

creators, subjects, genre, other titles, related titles, publisher, creation date, format, source, and local notes.

39. Page 3 of **Appendix 1010C** is the MARC record. The first six digits of Field 008 show the record was created on “970717” (*i.e.*, July 17, 1997). Field 005 is a machine-generated field that automatically records the last time this record was modified by the library, and it shows the last time the library of the US Naval Academy modified this record was “19970723081302” (*i.e.*, July 23, 1997, 8 a.m., 13 minutes, 2 seconds). Subfields “a” and “c” of Field 040 show “NSA” (National Security Agency) created the original MARC record, and subfield “d” shows “UNA” (US Naval Academy) modified the record later. Data from Field 008, 040 and 005 inform my opinion that the library of NSA created the first MARC record for this conference proceedings on July 17, 1997, and the library of the US Naval Academy later used that record as the basis for their copy cataloging. In addition, the last time this record was modified by the library of the US Naval Academy was July 23, 1997. These data indicate that the MARC record for the conference proceedings containing *Tufvesson* was included in the library online catalog of the US Naval Academy no later than July 23, 1997. This fact is supported by Fields 945 that show the three volumes of this conference proceedings were added to the collection on “7-23-97” (meaning July 23, 1997).

40. Fields 020 show four ISBNs of this publication, Field 111 shows the

conference name is included as the author of this work. Field 245 shows the title of the conference proceedings, Fields 246 show five variant titles are included in the MARC record to help users discover this work. Field 260 shows the publisher and copyright date, Field 300 shows the physical description, Fields 500 show two IEEE catalog numbers, Fields 710 show the Vehicular Technology Society, and the Institute of Electrical and Electronics Engineers, Phoenix Section, are included to help users discover this work.

41. Subjects are represented in Field 050 by a Library of Congress Classification (LCC) number of “TK6570.M6” that represents “Mobile communication systems” and in Fields 650 by three Library of Congress subject headings, with “Electronics in transportation,” “Mobile communication systems,” and “Artificial satellites in telecommunication” as the main topics, each followed by a form subheading “Congresses” encoded in subfield “v” to indicate the main topics are treated at a conference. These subject representations support users to conduct subject searches to locate this conference proceedings.

42. This MARC record (**Appendix 1010C**) shows that the conference proceedings containing *Tufvesson* was published in 1997, and the MARC record made this work discoverable by July 23, 1997, in the online catalog of the library of the US Naval Academy. As discussed earlier, a common library practice is to process newly cataloged monographs quickly for public access, usually within a

week after the cataloging work is completed and the MARC record is added to the online catalog. It is therefore my opinion that the copy of this conference proceedings (and *Tufvesson* contained therein) would have been publicly accessible at this library by July 30, 1997.

E. Linda Hall Library Records

43. My research in WorldCat on the conference proceedings containing *Tufvesson* also identified Linda Hall Library as a holding library. Their records are discussed below to show the public availability of this conference proceedings at Linda Hall Library.

44. **Appendix 1010D** is a true and correct copy of the bibliographic and MARC records for *1999 IEEE 47th Vehicular Technology Conference, Technology in Motion* that contains *Tufvesson*. I personally located, identified, and obtained these records from the online catalog of the Linda Hall Library. These are the type of research experts in my field would reasonably rely upon when forming their opinions.

45. Pages 1 to 3 of **Appendix 1010D** are the bibliographic record that shows the conference proceedings containing *Tufvesson* is a conference proceeding that is available at “Linda Hall Library Books – 2nd Floor (TK6570.M6 I23 1997).” The “Location Items” area shows this proceedings has three volumes and all of them are “loanable” (meaning users can access these volumes). The detailed record on

pages 2 and 3 shows the title, other title, creators, subjects, identifiers (ISBNs and OCLC number), publisher, creation date, format, and general notes.

46. Page 4 is the MARC record. The first six digits of Field 008 show the record was created on “970717” (*i.e.*, July 17, 1997). Field 005 is a machine-generated field that automatically records the last time this record was modified by the library, and it shows the last time Linda hall Library modified this record was “19970723000000” (*i.e.*, July 23,1997). Subfields “a” and “c” of Field 040 show “NSA” (National Security Agency) created the original MARC record, and subfield “d” shows “LHL” (Linda Hall Library) modified the record later. Data from Fields 008, 040 and 005 inform my opinion that the library of NSA created the first MARC record for this conference proceedings on July 17, 1997, and Linda Hall Library used that record as the basis for their copy cataloging. In addition, the last time this record was modified by Linda Hall Library was July 23, 1997. These data indicate that the MARC record for the conference proceedings containing *Tufvesson* was included in the library online catalog of the Linda Hall Library no later than July 23, 1997.

47. Because the Linda Hall Library MARC record (**Appendix 1010D**) and the Naval Academy library MARC record (**Appendix 1010C**) are both copy cataloging records based on the same record created by the library of NSA, these two MARC records have a lot in common, including ISBNs in Fields 020, conference name in Field 111, title in Field 245, three variant titles in Fields 246,

publisher and copyright date in Field 260, physical description in Field 300, IEEE catalog numbers in Fields 500, two related organizations in Fields 710, Library of Congress classification number of “TK6570.M6,” and subject headings in Fields 650.

48. This MARC record (**Appendix 1010D**) shows that the conference proceedings containing *Tufvesson* was published in 1997, and the MARC record made this work discoverable by July 23, 1997, in the online catalog of the Linda Hall Library. As discussed earlier, a common library practice is to process newly cataloged monographs quickly for public access, usually within a week after the cataloging work is completed and the MARC record is added to the online catalog. It is therefore my opinion that the copy of this conference proceedings (and *Tufvesson* contained therein) would have been publicly accessible at Linda Hall Library by July 30, 1997.

F. Usage Record

49. Actual usage of a publication is reflected by the papers that make reference to it. The citation history on Google Scholar shows that *Tufvesson* has been cited 315 times. **Appendix 1010E** is a list of citations from 1998 and 1999 to demonstrate early usage. The earliest citation is an IEEE article published in February 1998.

G. Summary of My Opinion on *Tufvesson*

50. The IEEE copy of *Tufvesson* (**Ex. 1010**) shows it was published in 1997, and the IEEE record for *Tufvesson* (**Appendix 1010A**) shows the metadata record was entered into the IEEE Xplore Digital Library on August 6, 2002, making *Tufvesson* publicly discoverable from that date on. Because IEEE Xplore is freely accessible on the Internet, interested users would have been able to search the system to discover *Tufvesson*. After that, they could obtain free access to the article through an institution with a subscription to IEEE Xplore Digital Library, or purchase the article from IEEE themselves. The copyright registration record for the conference proceedings containing *Tufvesson* (**Appendix 1010B**) shows the conference proceedings was published on May 5, 1997. MARC records from the US Naval Academy Library (**Appendix 1010C**) and Linda Hall Library (**Appendix 1010D**) show the conference proceedings containing *Tufvesson* became discoverable in their online catalogs by July 23, 1997. Citation history shows the earliest citation to *Tufvesson* appeared in February 1998. All the records I have reviewed support my opinion that the conference proceedings containing *Tufvesson* became discoverable by July 23, 1997, and copies of the proceedings (and *Tufvesson* contained therein) would have been publicly accessible at libraries by July 30, 1997, which is several years before the February 2004 critical date.

III. Conclusion

51. In signing this declaration, I recognize that the declaration will be filed as evidence in a Petition for *Inter Partes* Review before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to deposition in the case. If deposition is required of me, I will appear at a reasonable time and place to be agreed upon.

52. I hereby declare that all statements made herein on 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.

Date: 3-26-2023

Executed: Ingrid Hsieh-Yee
Ingrid Hsieh-Yee, Ph.D.

Appendix A

Ingrid Hsieh-Yee
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Education

Ph.D. 1990. Library and Information Studies, University of Wisconsin-Madison
Minors: Sociology and Psychology

M.A. 1984. Library and Information Studies, University of Wisconsin-Madison.

M.A. 1983. Comparative Literature, University of Wisconsin-Madison.

B.A. 1980. Foreign Languages and Literature, National Taiwan University.

Work Experience

Professor, School/Dept. of Library and Information Science, Catholic University of America,
1990-2022 (Assistant Professor, 1990-1996; Associate Professor, 1997-2004; Professor
2004-2022; Professor Emerita 2022)

Co-Chair, Dept. of Library and Information Science, Catholic University of America, June 2015-
August 2016.

Acting Dean, School of Library and Information Science, Catholic University of America,
January 2010-June 2012.

Cataloger, Dept. of Legislative Reference Library, Annapolis, Maryland, 1989-1990.

Lecturer, School of Library and Information Studies, University of Wisconsin-Madison, 1988.

Teaching Assistant, School of Library and Information Studies, University of Wisconsin-
Madison, 1986-1988.

Cataloger, Health Sciences Library, University of Wisconsin-Madison, 1984-1986.

Areas of Teaching and Research Interests

Information Organization and Access; Metadata; Cataloging & Classification; Information
Architecture; Information Retrieval; Digital Collections; Social Media; Scholarly

Communication; Information Behavior; Health Informatics; Human Computer Interaction; Usability Studies

Grants & Honors

Cultural Heritage Information Management Project. IMLS grant. Amount: \$498,741. Period: Aug. 2012 to July 2015. Co-PI with Dr. Youngok Choi.

D.C. Health Information Technology (HIT4): Building Capacity & Providing Access in Our Nation's Capital. Dept. of Labor H2B Training Grant. Grant amount: \$4,175,500. Grant period: Nov. 2011 to Dec. 2015. Partner with the Metropolitan School of Professional Studies of the Catholic University of America, Children's National Medical Center, D.C. Department of Employment Services, Holy Cross Hospital, Howard University, Center for Urban Progress, Providence Hospital, and Sibley Memorial Hospital.

Capital Health Careers Project. Department of Labor Healthcare Sector and Other High Growth and Emerging Industries Grant. Grant amount: \$4,953,999. Grant period: March 2010 – February 2013. Awarded to a group of healthcare organizations and educational institutions in Washington, D.C. Providence Health Foundation of Providence Hospital (Lead institution). Part of the grant supported the development of a Master's degree program in Information Technology with a concentration in Health Information Technology offered by the School of Library and Information Science.

The Washington D.C. School Librarians Project. IMLS grant. Grant amount: \$412,660. Grant period: Aug. 2007 – June 2011. The School partnered with the District of Columbia Public Schools (DCPS) and the District of Columbia Library Association to educate and mentor school media specialists for the DCPS system. PI, Jan. 2010 to June 2011.

SIG Member of the Year, American Society for Information Science and Technology (2009).

Most Outstanding Paper of *OCLC Systems & Services* (2001).

ALISE Research Grant (2001).

Most Outstanding Paper of *OCLC Systems & Services* (2000).

Research Grant from ERIC (1999-2000).

Best Research Paper Award; Association for Library and Information Science Education (1998).

Research Grants, Catholic University of America. 1991, 1992, 1993, 1996, 1998, 1999, 2004, 2005, 2006, 2007, 2013-14.

Cooperative Faculty Research Grant, Consortium of Universities in the Washington Metropolitan Area (1993-1994).

Cooperative Research Grant, Council on Library Resources (1993-1994).

Journal of the American Society for Information Science Best Paper Award (1993).

ASIS/ISI Information Science Doctoral Dissertation Scholarship (1989).

HEA Title IIB Fellowship (Dept. of Education) (1989)

Chinese-American Librarians Association Scholarship (1987).

Beta Phi Mu (1985).

Vilas Fellowship, University of Wisconsin-Madison. 1984

Publications

Hsieh-Yee, I. (2021). Can We Trust Social Media? *Internet Reference Services Quarterly*, 1-15.
Published online: 28 July, 2021. 10.1080/10875301.2021.1947433.

Bailey, T., & Hsieh-Yee, I. (2020). Combating the Sharing of False Information: History, Framework & Literacy Strategies, *Internet Reference Services Quarterly*, 24 (1-2), 9-30.

Choi, Y., and Hsieh-Yee, I. (2010). Finding Images in an OPAC: Analysis of User Queries, Subject Headings, and Description Notes. *Canadian Journal of Information and Library Science*, 34(3): 271 – 295.

Hsieh-Yee, I. (2008). Educating Cataloging Professionals in a Changing Information Environment. *Journal of Education for Library and Information Science*, 46(2): 93-106.

Vellucci, S. L., Hsieh-Yee, I., and Moen, W.E. (2007). The Metadata Education and Research Information Commons (MERIC): A Collaborative Teaching and Research Initiative. *Education for Information*, 25(3&4): 169-178.

NISO Framework for Guidelines for Building Good Digital Collections. 3rd ed. Baltimore, MD: National Information Standards Organization, 2007. Also available online: <http://www.niso.org/framework/framework3.pdf> (NISO Working Group members: Priscilla Caplan (chair), Grace Agnew, Murtha Baca, Tony Gill, Carl Fleischhauer, Ingrid Hsieh-Yee, Jill Koelling, and Christie Stephenson.)

Choi, Y., Hsieh-Yee, I., and Kules, B. (2007). Retrieval Effectiveness of TOC and LCSH. *Proceedings of the Joint Conference on Digital Libraries*, pp. 233-234.

Vellucci, S., and Hsieh-Yee, I. (2007). They Didn't Teach Me That in Library School! Building

a Digital Teaching Commons to Enhance Metadata Teaching, Learning and Research. *Proceedings of the National Conference of the Association of College and Research Libraries, Baltimore, MD*, pp. 26-31.

Mitchell, Vanessa, and Ingrid Hsieh-Yee. (2007). Converting Ulrich's Subject Headings to FAST Headings: A Feasibility Study. *Cataloging & Classification Quarterly*, 45(1): 59-85.

Hsieh-Yee, I., Tang, R., and Zhang, S. (2007). User Perceptions of a Federated Search System. *IEEE Technical Committee on Digital Libraries Bulletin*, Summer 3(2) (URL = <http://www.ieee-tcdl.org>).

Tang, R., Hsieh-Yee, I., and Zhang, S. (2007). User Perceptions of MetaLib Combined Search: An Investigation of How Users Make Sense of Federated Searching." *Internet Reference Services Quarterly*, 12(12): 211-236.

Hsieh-Yee, I., Tang, R., and Zhang, S. (2006). User Perceptions of a Federated Search System. *Proceedings of the Joint Conference on Digital Libraries, June 11-15, 2006, Chapel Hill*, p. 338.

Hsieh-Yee, I. (2006). *Organizing Audiovisual and Electronic Resources for Access: A Cataloging Guide*. 2nd ed. Westport, Conn.: Libraries Unlimited.

NISO A Framework of Guidance for Building Good Digital Collections. 2nd ed. Bethesda, MD: National Information Standards Organization, 2004. Framework Advisory Group: Grace Agnew, Liz Bishoff, Priscilla Caplan (Chair), Rebecca Gunther and Ingrid Hsieh-Yee.

Hsieh-Yee, I. (2004). Cataloging and Metadata Education in North American LIS Programs. *Library Resources & Technical Services*, 48(1): 59-68.

Hsieh-Yee, I. (2004). Cataloging and Metadata Education. In Gary E. Gorman (Ed.), *International Yearbook of Library and Information Management 2003: Metadata Applications and Management*, (pp.204-234). London: Facet Publishing.

Yee, P. L., Hsieh-Yee, I., Pierce, G.R., Grome, R., and Schantz, L. (2004). Self-Evaluative Intrusive Thoughts Impede Successful Searching on the Internet. *Computers in Human Behavior*, 20(1): 85-101.

Hsieh-Yee, I. (2003). Cataloging and Metadata Education: A Proposal for Preparing Cataloging Professionals of the 21st Century. A report submitted to the ALCTS-Education Task Force in response to Action Item 5.1 of the *Bibliographic control of Web Resources: A Library of Congress Action Plan*. Approved by the Association for Library Collections and Technical Services. Web version available since April 2003 at <http://lcweb.loc.gov/catdir/bibcontrol/CatalogingandMetadataEducation.pdf>.

- Hsieh-Yee, I. (2002). Cataloging and Metadata Education: Asserting a Central Role in Information Organization. *Cataloging & Classification Quarterly* 34(½): 203-222.
- Hsieh-Yee, I., and Smith, M. (2001). The CORC Experience: Survey of Founding Libraries, Part I. *OCLC Systems & Services*, 17: 133-140. (Received "The Most Outstanding Paper of OCLC Systems & Services in 2001" award.)
- Hsieh-Yee, I., and Smith, M. (2001). The CORC Experience: Survey of Founding Libraries, Part II, Automated Tools and Usage. *OCLC Systems & Services*, 17: 166-177. (Received "The Most Outstanding Paper of OCLC Systems & Services in 2001" award.)
- Hsieh-Yee, I. (2001). ERIC User Services: Changes and Evaluation for the Future. *Government Information Quarterly*, 18: 31-42.
- Hsieh-Yee, Ingrid. (2001). Research on Web Search Behavior. *Library and Information Science Research*, 23: 167-185.
- Logan, E., and Hsieh-Yee, I. (2001). Library and Information Science Education in the Nineties. *Annual Review of Information Science and Technology*, 35: 425-477.
- Hsieh-Yee, I. (Ed.) (2001). *Library and Information Science Research*, 23 (2). A special issue in honor of the retirement of Douglas L. Zweizig.
- Hsieh-Yee, I. (2000). *ERIC User Services: Evaluation in a Decentralized Environment*. Washington, D.C.: Dept. of Education.
- Hsieh-Yee, Ingrid. (2000). *Organizing Audiovisual and Electronic Resources for Access: A Cataloging Guide*. Littleton, CO: Libraries Unlimited.
- Hsieh-Yee, I. (2000). Organizing Internet Resources: Teaching Cataloging Standards and Beyond. *OCLC Systems & Services*, 16: 130-143. (Received "The Most Outstanding Paper of OCLC Systems & Services in 2000" award.)
- Hsieh-Yee, I. (1998). The Retrieval Power of Selected Search Engines: How Well Do They Address General Reference Questions and Subject Questions? *Reference Librarian*, 60: 27-47.
- Hsieh-Yee, I. (1998). Search Tactics of Web Users in Searching for Texts, Graphics, Known Items and Subjects: A Search Simulation Study. *Reference Librarian*, 60: 61-85. (Received the 1997 Best ALISE Research Paper Award.)
- Hsieh-Yee, I. (1997). Access to OCLC and Internet Resources: LIS Educators' Views and Teaching Practices. *RQ*, 36: 569-86.

- Hsieh-Yee, I. (1997). Teaching Online and CD-ROM Resources: LIS Educators' Views and Practices. *Journal of Education for Library and Information Science*, 38: 14-34.
- Hsieh-Yee, I. (1996). The Cataloging Practices of Special Libraries and Their Relationship with OCLC. *Special Libraries*, 87: 10-20.
- Hsieh-Yee, I. (1996). Modifying Cataloging Practice and OCLC Infrastructure for Effective Organization of Internet Resources. In *Proceedings of the OCLC Internet Cataloging Colloquium*. [Online]. Available: <http://www.oclc.org/oclc/man/colloq/hsieh.htm>
- Hsieh-Yee, I. (1996). Student Use of Online Catalogs and Other Information Channels. *College & Research Libraries*, 57: 161-175.
- Hsieh-Yee, I. (1995). Ten entries in James S. C. Hu (Ed.), *Encyclopedia of Library & Information Science*, 913, 1028-29, 1036, 1037, 1145-46, 1514, 1575, 1763-64, 2216-27, 2378-79. Taipei, Taiwan: Sino-American Publishing. (Topics include "Advanced Technology/Libraries," "Information Ethics," "Instruction on Cataloging and Classification," "Instruction on Reference Services.")
- Hsieh-Yee, I. (1993). Effects of Search Experience and Subject Knowledge on Online Search Behavior: Measuring the Search Tactics of Novice and Experienced Searchers. *Journal of the American Society for Information Science*, 44: 161-174. (Received the 1993 Best JASIS Paper Award.)

Works in Progress

- Hsieh-Yee, I. Actionable lessons for debunking false information: A comparative analysis of literacy lessons in communication and library and information science
- Hsieh-Yee, I. Representing diverse voices and communities in cataloging and indexing: The evolution of controlled vocabularies
- Hsieh-Yee, I. Information Organization and Retrieval in Practice (a monograph scheduled for completion and publication in 2023)

Presentations

- Bailey, T. & Hsieh-Yee, I. (February 2020). The Phenomena of Sharing Misinformation and the Need for Information Literacy. Presented at the 2020 Bridging the Spectrum Symposium, Washington, D.C., February 14, 2020.

- Hsieh-Yee, I. and Fragan-Fly, J. (May 2018) Trends, Design & Strategies for Digital Scholarship Services. Presented at the 2018 Maryland/Delaware Library Association Conference, Cambridge, MD.
- Hsieh-Yee, I. (February, 2018) Research Data Management: What It Takes to Succeed. Presented at the 10th Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee, I. (February, 2017) *Research Data Management: New Competencies and Opportunities for Information Professionals*. Presented at the 9th Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee, I. and Lawton, P. (February, 2017) *Enhancing Catholic Portal Searches with User Terms and LCSH*. Presented at the 9th Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee, I. (2016, October) *Visualizing Data for Information*. Presented at the 2016 Virginia Library Association Conference, Hot Springs, VA.
- Hsieh-Yee, I. (2016, August) *Religious Materials Toolbox for Archivists: Solutions to Problems Facing the Profession*. Presented at Archives * Records 2016, Atlanta, GA.
- Hsieh-Yee, I. and Lawton, P. (2016, March) *Enhancing Retrieval of Catholic Materials with LCSH Knowledge Structure*. Presented at the 2016 Catholic Library Association Conference, San Diego, CA.
- Fagan-Fry, J. and Hsieh-Yee, I. (2016, February) *Approaches to Digital Scholarship at Top Universities around the World: Scholarly Publishing in the Digital Age*. Presented at the 8th Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee and Fagan-Fry, J. (2016, January) *Innovative Services for Digital Scholarship at Top 100 Research Libraries of the World*. Poster presented at the 2016 Annual Conference of the Association for Library and Information Science Education, Boston, Mass.
- Hsieh-Yee, I. and Lawton, P. (2015, June). *Crowdsourcing terms for CRRA portal themes*. Poster presented at the third CRRA symposium and annual meeting, Bringing the created toward the Creator: Liturgical art and design since Vatican II. Catholic Theological Union, Chicago, Illinois.
- Hsieh-Yee, I. and Lawton, P. (2015, February). *Crowdsourcing terms for thematic exploration in the Catholic Portal*. Poster presented at the 7th Annual Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee, I., James, R., and Fagan-Fry, J. (2015, February). *Support for digital scholarship at top university libraries of the world*. Poster presented at the 7th Annual Bridging the Spectrum Symposium, Washington, D.C.

- Hsieh-Yee, I., Zhang, S., Lin, K., and Cherry, S. (2015, February). *Thus said the end users: Summon experience and support for research workflows*. Poster presented at the 7th Annual Bridging the Spectrum Symposium, Washington, D.C.
- Yontz, E., Hsieh-Yee, I., & Houston, S. (2015, February). *Healthy Heroes Summer Reading Club: Developing healthy youth at public libraries*. 11th Annual Jean Mills Health Symposium, Greenville, North Carolina.
- Yontz, E., Hsieh-Yee, I., and Houston, S. (2015, January). *Healthy youth and libraries: A pilot study*. Association for Library & Information Science Education (ALISE) Annual Conference, Chicago, Illinois.
- Hsieh-Yee, I. (2014, May). *Linking CRRRA resources to portal themes via authority files*. Presented at the Catholic Research Resources Alliance 2014 Membership Meeting, Marquette, WI.
- Hsieh-Yee, I. (2014, April). *Enhancing subject access to CRRRA resources*. Presented at the 2014 Catholic Library Association Conference, Pittsburgh, PA.
- Hsieh-Yee, I. (2014, January). *Health Information Technology Program: Educational entrepreneurship in action*. Presented at the 2014 annual Conference of the Association for Library and Information Science Education, Philadelphia, PA.
- Hsieh-Yee, I., Zhang, S., Lin, K., and Cherry, S. (2014, January). *Discovering information through Summon: An analysis of user search strategies and search success*. Paper presented at the 6th Bridging the Spectrum Symposium, Washington, D.C.
- Hsieh-Yee, I. (2012, December). *National Digital Stewardship Alliance and SLIS at CUA: An Educational Partnership*. Paper presented at Best Practices Exchange: Acquiring, Preserving, and Providing Access to Government Information in the Digital Era, Annapolis, MD.
- Choi, Y. and Hsieh-Yee, I. (2010, January). *Finding Images in an OPAC: Analysis of User Queries, Subject Headings, and Description Notes*. Paper presented at 2nd Annual Bridging the Spectrum Symposium, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I. and Coogan, J. (2010, January). *Google Scholar vs. Academic Search Premier: What Libraries and Searchers Need to Know*. Paper presented at 2nd Annual Bridging the Spectrum Symposium, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I. (2009, November). *Information Science Education: An LIS School's Perspective*. Paper presented at Annual Meeting of the American Society for Information Science and Technology, Vancouver, British Columbia, Canada.

- Hsieh-Yee, I., Menard, E., Ya-Ning Chen, A., Shu-Jiun Chen, S., Kalfatovic, M. R., Wisser, K. M. (2009, November). *Information Organization in Libraries, Archives and Museums: Converging Practices and Collaboration Opportunities*. Presented at Annual Meeting of the American Society for Information Science and Technology, Vancouver, British Columbia, Canada. (Organizer and moderator of this panel.)
- Hsieh-Yee, I. and Coogan, J. (2009, July). *Catching up to Google Scholar: The Retrieval Power of Academic Search Premier and Google Scholar*. Poster presented at American Library Association Conference, Chicago, Illinois.
- Hsieh-Yee, I., with the CUA Scholarly Communications Project Team. (2009, January). *Digital Scholarship@CUA: Developing an Institutional Repository for CUA*. Poster presented at 1st Annual Bridging the Spectrum Symposium, Catholic University of America, Washington, D.C.
- Wise, M., Cylke, K., and Hsieh-Yee, I. (2009, January). *Digital Talking Books: Meeting the Needs of the Blind and the Handicapped*. Paper presented at the Bridging the Spectrum Symposium, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I. (2009, January). *User Expectations of MERIC*. Presented at the Information Organization Competencies for the 21st Century Discussion Session of the 2009 Conference of the Association for Library and Information Science Education, Denver, Colorado.
- Choi, Y., and Hsieh-Yee, I. (2008, November). *Subject Access for Images in an OPAC*. Annual Meeting of the American Society for Information Science and Technology, Columbus, Ohio. (Also co-organized a panel on Retrieving and Using Visual Resources: Challenges and Opportunities for Research and Education.)
- Hsieh-Yee, I. (2008, June). *Educating Cataloging Professionals in a Changing Information Environment*. National Taiwan University, Taipei, Taiwan.
- Vellucci, S. L., Moen, W.E., Hsieh-Yee, I., Marson, B., and Wisser, K. (2008, January) *Building a Metadata Education and Research Community through MERIC (Metadata Education and Research Information Commons): Demo and Stakeholder Input*. A panel presented at the 2008 Conference of the Association for Library and Information Science Education, Philadelphia, Pennsylvania.
- Hsieh-Yee, I., Choi, Y. and Kules, B. (2007, October). *Searching for Books and Images in OPAC: Effects of LCSH, TOC and Subject Domains*. A poster presented at the American Society for Information Science and Technology Annual Meeting, Milwaukee, Wisconsin.
- Hsieh-Yee, I. and Coogan, J. (2007, August) *Google Scholar vs. Academic Search Premier: A Comparative Analysis*. Presented to the Faculty and Staff of the University of the District

of Columbia.

- Hsieh-Yee, I. and Coogan, J. (2007, June). *Google Scholar vs. Academic Search Premier: A Comparative Analysis*. Presented to the Washington Research Library Consortium Community, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I., Choi, Y., and Kules, B.. (2007, June). *What Users Need for Subject Access: Table of Contents or Subject Headings?* A poster presented at the 2007 American Library Association Annual Conference, Washington, D.C., June 2007.
- Choi, Y., Hsieh-Yee, I., and Kules, B. (2007, June). *Retrieval Effectiveness of TOC and LCSH*. A paper presented at the Joint Conference on Digital Libraries 2007, Vancouver, Canada.
- Vellucci, S. L., Hsieh-Yee, I., and Moen, W.E. (2007, May). *If We Build It, Will They Come? Building a Community of Practice for Metadata Stakeholders*. A poster presented at the Rutgers University Research Day, Bridgeton, New Jersey.
- Hsieh-Yee, I. (2007, May). *Federated Searching: User Experience & Perceptions*. International Conference on Information Organization & Retrieval, National Taiwan University, Taipei, Taiwan.
- Hsieh-Yee, I. (2007, May). *Search Performance of Google Scholar and Academic Search Premier*. International Conference on Information Organization & Retrieval, National Taiwan University, Taipei, Taiwan.
- Hsieh-Yee, I. (2007, May) *MERIC: Building a Digital Commons for Metadata Education & Research*. International Conference on Information Organization & Retrieval, National Taiwan University, Taipei, Taiwan.
- Hsieh-Yee, I., and Coogan, J. (2007, March/April). *A Comparative Analysis of Google Scholar and Academic Search Premier*. Poster presented at the Association of College & Research Libraries 13th National Conference, Baltimore, Maryland.
- Vellucci, S. L. and Hsieh-Yee, I. (2007, March/April) *They Didn't Teach Me That in Library School! Building a Digital Teaching Commons to Enhance Metadata Teaching, Learning and Research*. On-site presentation and Webcast by Elluminate. A contributed paper presented at the Association of College & Research Libraries 13th National Conference, Baltimore, Maryland. The acceptance rate for contributed paper was 20%. This paper was one of 10 conference papers chosen for live webcast during the conference.
- Moen, W., Hsieh-Yee, I. and Vellucci, S.L. (2007, January) *A DSpace Foundation for a Teaching & Research Commons: The Metadata Education and Research Information Commons*. A poster session presented at the Open Repositories Conference 2007, San Antonio, Texas.

- Tang, R., Hsieh-Yee, I., and Zhang, S. (2006, November) *User Perception of MetaLib Combined Search*. Paper presented at the Annual Meeting of the American Society for Information Science and Technology, Austin, Texas, Nov. 2006.
- Hsieh-Yee, I. (2006, November). *Federated Searching: User Perceptions, System Design, and Library Instructions*. Paper presented at the Annual Meeting of the American Society for Information Science and Technology, Austin, Texas. (Panel organizer, moderator, presenter).
- Hsieh-Yee, I. (2006, November). *Building a Digital Teaching Commons to Enhance Teaching and Learning: The MERIC Experience and Challenges*. Paper presented at the Annual Meeting of the American Society for Information Science and Technology, Austin, Texas. (Panel organizer, moderator, presenter)
- Hsieh-Yee, I. (2006, September). *Search Performance of Google Scholar and Academic Search Premier*. Paper presented at the ERIC Publishers Meeting, Washington, D.C.
- Hsieh-Yee, I., Zhang, S., and Rong Tang, R. (2006, June). *User Perceptions of a Federated Search System*. Poster presented at Joint Conference on Digital Libraries, Chapel Hill, North Carolina.
- Hsieh-Yee, I. and Zhang, S. (2006, June). *Preparing Users for Federated Search: Implications of a MetaLib User Perceptions Study*. Paper presented at the 2006 Ex Libris User Groups of North America Conference, Knoxville, Tennessee.
- Hsieh-Yee, I. (2006, January). *MERIC Organizations and Navigation*. Paper presented at the 2006 ALISE Annual Conference, San Antonio, Texas.
- Hsieh-Yee, I. (2006, January). *Metadata and Cataloging Education: Recommended Competencies*. Paper presented at the 2006 ALISE Annual Conference, San Antonio, Texas.
- Hsieh-Yee, I. (2005, November). *Digital Library Evaluation: Progress & Next Steps*. Presentation at the Annual Meeting of the American Society for Information Science & Technology, Charlotte, North Carolina.
- Hsieh-Yee, I. (2005, August). *Providing Access to Digital Content: Issues for DL Managers*. Presentation at MDK12 Digital Library Steering Committee Meeting, Columbia, Maryland.
- Hsieh-Yee, I. (2005, April). *Enhancing Teaching and Learning: The Role of School Library Media Specialists*. Presentation at Meeting of the Baltimore County Public School System School Media Specialists, Baltimore, Maryland.

- Hsieh-Yee, I. (2005, January). *Subject Access and Users: Insights & Inspirations from Marcia J. Bates*. Paper presented at the Historical Perspectives SIG, 2005 Conference of the Association for Library and Information Science Education, Boston, Massachusetts.
- Hsieh-Yee, I. (2005, January). *Electronic Resource Management: Practice, Employer Expectations, & CE Interests*. Paper presented at Technical Services Education SIG, 2005 Conference of the Association for Library and Information Science Education, Boston, Massachusetts.
- Hsieh-Yee, I. (2004, October). *Library Professionals for the Digital Age: Competencies & Preparation*. Paper presented at Bibliographic Access Management Team meeting, Library of Congress, Washington, D.C.
- Hsieh-Yee, I. (2004, January). *Cataloging and metadata expertise for the digital era*. Presented at Preparing 21st Century Cataloging and Metadata Professionals: A Workshop for Educators and Trainers, San Diego and sponsored by ALCTS, ALISE, LC, and OCLC.
- Hsieh-Yee, I. (2004, January). *Educating catalogers for the digital era*. Paper presented at the Technical Services SIG, 2004 Conference of the Association for Library and Information Science Education, San Diego.
- Hsieh-Yee, I. (2003, July). *Cataloging Education for the 21st Century*. A presentation at the Library of Congress, Washington, D.C.
- Hsieh-Yee, I. (2002, January) *Metadata Education and Research Priorities: A Delphi Study of Metadata Experts*. Presentation at the 2002 Conference of the Association for Library and Information Science Education, New Orleans.
- Hsieh-Yee, I. (2001, November). *A Delphi Study of Metadata: Preliminary Findings*. Poster session at the 2001 Annual Meeting of the American Society for Information Science & Technology, Washington, D.C.
- Hsieh-Yee, I. (2001, June). *Resources on Asian American Children: Analysis of Retrieval by Search Engines and WorldCat*. Presentation at the National Conference on Asian Pacific American Librarians, San Francisco.
- Hsieh-Yee, I. (2001, January). *Delphi Study on Metadata: Project Design*. Presentation at Research Awards Session, Association for Library & Information Science Education, Washington, D.C.
- Hsieh-Yee, I. (2000, May). *Web Search Behavior Research: Progress and Implications*. Presentation at the Symposium on Evaluating Library and Information Science Research, University of Wisconsin-Madison, Madison, Wisconsin.

- Hsieh-Yee, I. (2000, March). *ERIC User Services: Evaluation in a Decentralized Environment*. Presentation at the National ERIC Joint Directors/Technical Meeting, Arlington, Virginia.
- Hsieh-Yee, I. (2000, January). *Enhancing Learning with Web Technology*. Presentation at Faculty Conversations, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I. (2000, January). *From Surrogates to Objects: CUA's Approaches to Organizing Electronic Resources*. Paper presentation at the Annual Conference of the Association for Library and Information Science Education, San Antonio, Texas.
- Yee, P., and Hsieh-Yee, I. (1997, November). *Individual Differences in Search Behavior on the WWW*. A poster session presented at the 38th Annual Meeting of the Psychonomic Society, Philadelphia, Pennsylvania.
- Hsieh-Yee, I. (1997, April). *Research + Marketing + Preparation = Job!* Presented at the "Workshop on Resume and Interview Techniques," Special Libraries Association, Student Chapter, Catholic University of America, Washington, D.C.
- Hsieh-Yee, I. (1997, February). *Creating CyberCatalogers: Education and Training*. Presentation at ALA's Midwinter Meeting, Washington, D.C.
- Hsieh-Yee, I. (1997, February). *Search Tactics of Web Users in Searching for Texts, Graphics, Known Items and Subjects: A Search Simulation Study*. Presented at the Conference of the Association for Library and Information Science Education, Washington, D.C.
- Hsieh-Yee, Ingrid. "Beginning Your Special Library/Information Center Career." Presented at SLA's "Career Day," Jan. 11, 1997, Catholic University of America.
- Hsieh-Yee, I. (1996, September). *The Roles of Library and Information Scientists in Managing Electronic Information*. Presentation at Hamilton College, Clinton, New York.
- Hsieh-Yee, I. (1996, May). *The Future of Cataloging as a Profession*. Presented at "The Cataloging Forum, Library of Congress, Washington, D.C.
- Hsieh-Yee, I. (1994, October). *The Impact of the Internet on OPACs*. Presented at the Third Workshop on User Interfaces for OPACs, Library of Congress, Washington, D.C.

Reports

- Hsieh-Yee, I., with Knowledge Management Competencies and Performance Action Group of the Federal Knowledge Management Initiative. "From Knowledge Management Competencies to Improved Organizational Performance." April 9, 2009.

- Hsieh-Yee, I., with Knowledge Practices Action Group of the Federal Knowledge Management Initiative. "KM Practice in Government Agencies: Findings and Recommendations." April 9, 2009.
- Hsieh-Yee, I. "Delphi Study on Metadata." 2001. Three quarterly reports submitted to the Association for Library and Information Science Education.
- Hsieh-Yee, I. "College Students' Information Channels: Patterns of Use and Possible Factors in Channel Selection." 1995. Submitted to the Catholic University of America.
- Hsieh-Yee, I. "The Information-Seeking Patterns of Scholars and Their Use of an Online Information System." 1994. Submitted to the Council on Library Resources.

Book Reviews

- Review of *The Measurement and Evaluation of Library Services*, by Sharon L. Baker and F. Wilfrid Lancaster. *Information Processing and Management* 30 (1994): 450-52.
- Review of *Subject Access to Films and Videos*, by Sheila S. Intner and William E. Studwell; and *Cataloging Unpublished Nonprint Materials*, by Verna Urbanski with Bao Chu Chang and Bernard L. Karon. *Information Processing and Management* 30 (1994): 449-50.
- Review of *Automated Information Retrieval in Libraries: A Management Handbook*, by Vicki Anders. *Journal of Library and Information Science* 19 (1993): 98-100.
- Review of *Full Text Databases*, by Carol Tenopir and Jung Soon Ro. *Information Processing and Management* 28 (1992): 667-68.
- Review of *Descriptive Cataloging for the AACR2R And USMARC: A How-to-Do It Workbook*, by Larry Millsap and Terry Ellen Ferl. *Information Processing and Management* 28 (1992): 809-11.
- Review of *MARC Manual: Understanding and Using MARC Records*, by Deborah J. Byrne. *Information Processing and Management* 28 (1992): 537-38.

Service

Professional Associations and Societies

- Library of Congress. RDA Training Program for the Profession. Co-authored with Tim Carlton. 2013-2014.
- 2014 Digital Preservation Outreach & Education Survey. Contributed to the design of the survey, 2014.
- National Digital Stewardship Alliance. Outreach Committee. 2011-2014.
- National Digital Stewardship Residency Program. Advisory Group, 2012-2013.
- FEDLINK Health Information Technology Advisory Council, 2011-2015.

- 2012 Joint Conference on Digital Libraries. Program Planning Committee, Pre-Conference Proposals Review Committee, 2012
- Catholic Research Resources Alliance. Five-Year Strategic Plan Task Force, 2011-2012
- Institute of Museum and Library Services. Grant reviewer. 2004, 2005, 2010.
- Association for Library and Information Science Education.
 - * ALISE Bodan Wynar Research Paper Award Committee, 2015, 2016, 2017
 - * ALISE Eugene Garfield Dissertation Award Competition, Jury, 2013, 2014
 - * ALISE Research Grant Competition Committee. Chair, 2012
 - * Pratt-Severn Faculty Innovation Award. Chair, 2009, 2010
 - * ALISE Doctoral Poster Jury, 2012
 - * “Information Organization Competencies for the 21st Century” Discussion session leader. 2009 Conference of the Association for Library and Information Science Education.
 - * Assisted Technical Services SIG Convener in organizing a program, “Building a Metadata Education and Research Community through MERIC (Metadata Education and Research Information Commons): Demo and Stakeholder Input” for the 2008 ALISE conference.
 - * Association for Library Collections and Technical Services/Association for Library and Information Science Education (ALCTS/ALISE) Metadata Education and Research Information Center (MERIC) Advisory Board, Co-Chair (with Sherry Vellucci), 2005-2007. Chair, 2008-2009 (leading the effort to build MERIC, a repository and collaborative space for metadata educators, practitioners, and researchers)
 - * Technical Services SIG, Convener, 2004-2005. Organized a program on “Electronic Resources Management: Current Practices, Employer Expectations, and Teaching Strategies” for the 2005 conference in Boston, Massachusetts.
 - * Technical Services SIG, Convener, 2003-2004. Organized a program on “Organizing Information with Metadata: Desired Competencies and Teaching Innovations” for the 2004 conference.
 - * Technical Services SIG, Convener, 1999-2000. Organized a program on "Teaching the Organization of Electronic Resources" for the 2000 conference.
 - * Curriculum SIG, Co-convener (with Sibyl Moses), 1996-97. Organized a program on “Government Information Policy” for the 1997 conference.
- American Society for Information Science & Technology.
 - * Reviewer, Conference program panel submissions and poster submissions, 2005, 2006, 2007, 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017
 - * Nomination Committee, 2009-2011
 - * Information Science Education Special Interest Group. American Society for Information Science and Technology. Chair-Elect, 2007-2008. Chair 2008-2009.
 - * Committee on Information Science Education. 1999-2006.
 - * Committee on Information Science Education. Organizing Committee for an orientation program for students at ASIS annual meetings, 1999-2001
 - * Committee on Information Science Education. Sub-committee on Student Welfare (focusing on issues related to master's education), 1998-2001

- * SIG ED. Organizing Committee for the "Seminar on Research and Career Development" for junior researchers. 1995-96 (chair), 1997-2001
- * ISI Doctoral Dissertation Proposal Scholarship Jury, 1997; 2001, 2002
- * Pratt-Severn Best Student Research Paper Award Jury. Chair. 1997
- * 1998 Midyear Meeting (referee of contributed papers), 1997
- * Organizer and moderator of the ASIS Doctoral Forum and the Doctoral Research Seminar 1994-1995
- * SIG Human Computer Interaction. Chair-Elect, Chair, 1993-1995
- * Doctoral Forum Award Jury, 1995
- * Best Student Paper Award Jury, 1995
- American Library Association.
 - * Committee on Accreditation, External Review Panelist, 2009- (site visiting team 2013-2014; site visiting team 2016-2017)
 - * Association for Library Collections and Technical Services Task Force on Competencies and Education for a Career in Cataloging, member, 2008-2009
 - * Facilitator for "What They Don't Teach in Library School: Competencies, Education and Employer Expectations for a Career in Cataloging," an Association for Library Collections and Technical Services Preconference, June 22, 2007 in Washington, D.C. Also a local liaison for bringing this program to the Catholic University of America.
 - * Facilitator for a discussion on "Effect of Electronic Resources on Technical Services" at ALA's Midwinter Meeting held in Feb. 1997 in Washington, D.C.
 - * International Relations Committee, Subcommittee Task Force for IFLA and China, 1994-1997
- Virginia Association of School Librarians. Scholarships and Awards Committee. 2010-2012
- Federal Knowledge Management Initiative, Knowledge Management Practices Action Group. Member. 2009 (leading the effort to build a knowledge management repository)
- Federal Knowledge Management Initiative, Knowledge Management Competencies & Learning Action Group. Member. 2009 (developing an action plan for helping government knowledge workers and government agencies to develop knowledge management competencies)
- National Center for Education Statistics. Technical Review Panel. 2008.
- External evaluator for a case of promotion to full professorship. University of Tennessee. 2008.
- National Information Standards Organization (NISO). Advisory Board, Revision of "IMLS Framework of Guidance for Building Good Digital Collections," 2004, 2007.
- Library of Congress, Bibliographic Control of Web Resources: A Library of Congress Action Plan. Principal Investigator of Action Item 5.1, focusing on cataloging and metadata education for students and new librarians, 2002-2003. (worked with the Association for Library Collections and Technical Services, Education Task Force)

- Chinese American Librarians Association
 - * Chinese American Librarians Association Outstanding Library Leadership Award in Memory of Dr. Margaret Chang Fung, Award Committee, 2016-2017
 - * Achievement Award Jury, 2000-2001
 - * CALA Goal 2000 Task Force, 1997
 - * Scholarship Committee, 1995, 1996-1997 (chair)
 - * Board of Directors, 1994-1997
 - * Publication Committee, 1993-1995
 - * International Relations Committee, 1993-1996
- SailorSM Assessment Advisory Group (An impact study of Sailor, Maryland's Public Information Network), 1995
- Editorial boards
 - Journal of Library & Information Science. Editorial Board, 2012-
 - Chinese American Librarians Association, *Occasional Papers Series*. Editorial Board, 2009-2016.
 - Library Quarterly*. Editorial Board, 2003-2008
 - Bulletin of the Medical Library Association*, 1994-97
 - Newsletter editor for the Chinese American Librarians Association, 1989-92
- Referee for the following journals
 - Information Processing and Management*
 - Journal of Digital Information*
 - Journal of Education for Library and Information Science*
 - Journal of Information Science*
 - Journal of Library & Information Science*
 - Journal of Library Metadata*
 - Journal of the American Society for Information Science & Technology*
 - Library and Information Science Research*
 - Library Quarterly*
- Expert reviewer, “Digital Library” course, Evaluation module, University of North Carolina, Chapel Hill, 2007-2008.
- Expert reviewer, “Information Organization” course, University of Michigan, Ann Arbor. 2007.

Catholic University of America

- Academic Senate Committee on Appointments and Promotions, 2005-2008
- Academic Senate Committee on Committees and Rules, 2009-2012, 2019-2022
- Academic Senate representative (for School of Arts & Sciences), 2017-2020

- Academic Senate representative (for School of Library & Information Science) 2003-2012
- Academic Senate Library Committee, Interim Chair (2007), Member, 2008-2012
- Academic Senate Committee on Computing, 1995-2003
- President's Administrative Council, 2010-2012
- Deans' Council, 2010-2012
- Academic Leadership Group, 2010-2012
- Graduate Board, 2010-2012
- School of Arts & Sciences, Committee on Appointments and Promotions, 2015-2019
- School of Arts & Sciences, Academic Council, 2015-2016.
- School of Arts & Sciences, Ordinary Professor Group, 2013-
- Doctoral Dissertation Defense Committee, Chair, Dept. of Psychology, 2016, 2017, 2018, 2019, 2020, 2021, 2022
- Doctoral Dissertation Defense Committee, Chair, Dept. of Education, 2014, 2015, 2017, 2018, 2019
- Doctoral Dissertation Defense Committee, Chair, National Catholic School of Social Services, 2019, 2020, 2021
- Doctoral Dissertation Defense Committee, Chair, School of Nursing, 2006, 2008
- CUA Scholarly Communication Project Team, Member (2007), Chair, 2008-2009
- Dean Search Committee, 1992-1994, 1998-1999, 2002-2003, 2006-2007
- Fulbright Review Panel, 2006
- CUA Service Learning Advisory Board, 2001-2002
- CUA Faculty Conversations on Enhancing Teaching and Learning through Technology, Planning Group, 1999-2001
- CUA Initiative on Technology and Teaching, 1998-2001

Dept. of Library and Information Science

- Admissions Committee, 2007-2009, Chair 2010-2012, Member 2013-2015, Member 2018-2022
- Appointments and Promotions Committee, 1991-2022
- Student advisement, 1990-2022
- 4+1 Bachelor to Master program, Program Advisor, 2014-2022
- LIS Minor, Advisor, 2017-2022
- Curriculum Committee, 2020-21 (Member), 2021-2022 (Chair)
- Scholarship & Awards Committee, 2016-2018, 2020-21
- Comprehensive examination editor, 2020-21
- Symposium, Colloquium, Lecture Series Committee, May 2018-May 2020 (Chair)
- Symposium and Colloquium Committee, fall 2016-May 2018
- Bridging the Spectrum Symposium session moderator, 2018, 2019, 2020, 2021

- Organization of Information Core Course Outcomes Assessment, 2019, 2020
- The Information Professions in Society Core Course Outcomes Assessment, 2019, 2020
- Community Services Librarianship, Course of Study Review and Revision, 2020
- Organization of Information, Course of Study Review and Revision, 2019
- Organization of Information, Competency and Course Offerings Review, 2018-2019
- Accreditation presentation, Chair, June 2015-August 2016
- Interim Co-Chair, June 2015-August 2016.
- Blended/OWL Learning Committee, spring 2016-2018
- Technology Committee, fall 2016-2017
- Comprehensive examination editor, 2016-2017, reader (every year since 1990)
- LIS Advisory Board, 2015-2016 (chair); fall 2016- May 2018 (member)
- Committee on Planning and Assessment, 2015-2016 (chair)
- Senior Faculty Committee, 2014-2016.
- Accreditation Steering Committee, 2014-2016 (Chair, 2015-2016)
- Accreditation Students Standard Committee, co-chair, 2014-2016
- Accreditation Mission, Goals, and Objectives Standard Committee, co-chair, 2014-2016
- Accreditation Curriculum Standard, member 2014-2-16
- Accreditation Administration and Finance Standard, member 2014-2016
- Cultural Heritage Information Management Project (IMLS-funded), Co-PI, 2012-2015
- Cultural Heritage Information Management Forum (scheduled for June 2015), Co-Organizer, 2013-2015
- Health Information Technology Interim Review Committee, 2015 (chair)
- Health Sciences Librarianship Advisory Group, 2015- (chair)
- Comprehensive examination editors, 2013-2014, 2016-2017
- National Digital Stewardship Alliance liaison, 2011-2014
- Advisory Board, Chair 2010-2012
- Academic Honesty Committee, Chair, 2008-2012
- Blended Learning Committee, 2010-2012
- Colloquium Committee, 2010-2012
- Comprehensive Examination Administration, 2010-2012
- Cultural Heritage Information Management Advisory Committee, 2010-2012 (chair), 2013-
- Curriculum Committee, 1991-2003, 2007-2009, Chair 2010-2012, member 2013-
- Curriculum Subcommittee on Comprehensive Examination, Chair 2009-2012
- Health Information Technology Advisory Board, Chair 2010-2012. Member 2013-
- Health Sciences Advisory Committee, 2009, Chair 2010-2012. Member 2013-
- HIT Expert Forum, Chair 2012. Member 2013-2015
- Health Information Technology Student Group Advisor, 2011-2012
- State Council for Higher Education of Virginia, SLIS Representative, 2010-2012
- Symposium Planning Committee, 2010-2012
- Website Management Team, Chair, 2010-2012
- Urban School Librarianship Project (IMLS-Funded), PI, 2007-2011 (chair, 2010-11)

- Failing Grades Committee, 1995-1997 (chair), 2000-2001 (chair), 2004-2005 (chair), 2007 (chair)-2011
- Faculty Search Committee, 1994-1998, 2002-2004, 2006 (chair), Fall 2007-2009, Chair fall 2009-2012
- Recruitment Committee, Chair 2010-2012
- Strategic Planning Committee, Chair 2010-2012
- Technology Committee, 2010-2012
- Accreditation Advisory Committee, 2007-2009
- Accreditation Coordinating Committee, 2007-2009
- Accreditation Steering Committee, 2007-2009
- SLIS Advisory Group, 2007-2009
- Accreditation Curriculum Standard Committee, Co-chair, 2007-2009
- Accreditation Faculty Standard Committee, Co-chair, 2007-2009
- LSC 551 Information Organization Review Team, Co-chair, 2008-2009, 2015-2016.
- Curriculum Subcommittee on Portfolios, 2009
- LSC 555 Information Systems in Libraries and Information Centers Review Team, contributor, 2008-2009
- Redesign of LSC 730 Use and Users of Libraries and Information. 2009-
- Development of a metadata institute that was taught as LSC 715 Organization of Internet Resources in 2008. The institute is being revised and will be offered in 2010 under a new course title.
- Development of lesson plans, assignments, and evaluation rubrics for LSC 606, Cataloging and Classification, for the School's NCATE accreditation. 2008
- Howard and Mathilde Rovelstad Scholarship Committee, Chair, 2004-2007
- Assistant Dean Search Committee, Chair, Fall 2007
- Liaison to the Association for Library Collections and Technical Services to bring its preconference program, Cataloging Education and Employer Expectations, to CUA during the 2007 American Library Association Annual Meeting in Washington, D.C.
- Organizer of the colloquium presentation and reception for Tamar Sadeh of Ex Libris on PRIMO June 2007
- Practicum review and design (work with potential supervisors, such as the American Indian Museum internship description revision) 2006-
- Comprehensive examinations (edits, proctoring, and grading), 1990-
- SLIS Web site redesign: Comments and suggestions. Fall 2007
- Conducted surveys of current students and alumni in preparation for the 2005 re-accreditation, 2004-2005
- Technology Committee, 1992-1999 (chair, 1996-1998), 2002-2003 (member)
- Colloquia Committee 1997-1999, 2002-2003.
- Advisor of the CUA Student Chapter of the American Society for Information Science and Technology, 2002-2003
- Visiting Professor Search Committee, 1999, 2000, 2001
- Leader, Participation in the CORC experiment, 1999-2000
- Advisor of the Special Libraries Association Student Chapter, 1993-1999; the group was recognized for outstanding leadership by SLA in 1999.

- COA planning Committee, Task Force on Electronic Presentation of SLIS Reports (team leader) 1997-1998
- COA Planning Committee, Subcommittee on Technology 1996-1998
- NLM practicum coordinator, 1997-1998
- Computer Literacy Workshops: Assisted with the development and evaluation of the workshops, 1996-1998
- Leader, Participation in the InterCat project, 1995-1997

Appendix B

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MARC 21 Reference Materials

[Part VII: A Summary of Commonly Used MARC 21 Fields](#)

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[Part IX: The Leader](#)

[Part X: Field 008 for Books](#)

Part VII:

A Summary of Commonly Used MARC 21 Fields

This is a summary of the MARC 21 tags used most frequently by libraries in entering their own bibliographic records. For full listings of all MARC 21 tags, indicators, and subfield codes, see *MARC 21 Format for Bibliographic Data*.

In the explanations on these pages:

Tags -- The tags (3-digit numbers) are followed by the names of the fields they represent. In this summary, and in the *MARC 21 Format for Bibliographic Data*, if a tag can appear more than once in one bibliographic record, it is labeled repeatable (R). If it can only be used once, it is labeled non-repeatable (NR). For example, a catalog record can have several subjects, so the tags for subject added entries (6XX) are labeled repeatable (R).

Indicators -- The use of indicators is explained in fields where they are used. Indicators are one-digit numbers. Beginning with the 010 field, in every field -- following the tag -- are two character positions, one for Indicator 1 and one for Indicator 2. The indicators are not actually defined in all fields, however. And it is possible that a 2nd indicator will be used, while the 1st indicator remains undefined (or vice versa). When an indicator is undefined, the character position will be represented by the character # (for blank space).

Subfield codes -- All the data in each field (beginning with the 010 field) is divided into subfields, each of which is preceded by a delimiter-subfield code combination. The most common subfield codes used with each tag are shown. Each subfield code is preceded by the character \$, signifying a delimiter. The name of the subfield follows the code.

In general, every field **MUST** have a subfield 'a' (**\$a**). One exception that is often seen is in Field 020 (ISBN), when the ISBN information (subfield **\$a**) is unavailable but the price (subfield **\$c**) is known. Some subfields are repeatable. In this summary, repeatability is noted for only the more common repeatable subfields.

Examples: Examples follow the explanation for each field. For clarity, one space has

been placed between the tag and the first indicator, one space has been placed between the second indicator and the first delimiter- subfield code, and one space has been inserted between the delimiter-subfield code and the subfield data.

010 Library of Congress Control Number -- (LCCN)

(NR, or Not Repeatable)

Indicators undefined.

Subfield used most often:

\$a -- Library of Congress control number

Example: 010 ## \$a ###86000988#

020 International Standard Book Number -- (ISBN)

(R, or Repeatable)

Indicators undefined.

Subfields used most often:

\$a -- International Standard Book Number

\$c -- Terms of availability (often a price)

\$z -- Cancelled/invalid ISBN (R)

Example: 020 ## \$a 0877547637

040 Cataloging source -- (NR)

Indicators undefined.

Subfields used most often:

\$a -- Original cataloging agency

\$c -- Transcribing agency

\$d -- Modifying agency (R)

Example: 040 ## \$a DLC
 \$c DLC
 \$d gwhs

100 Main entry -- Personal name -- (primary author)

(NR; there can be only one main entry)

Indicator 1: Type of personal name entry element

0 -- Forename

1 -- Surname (this is the most common form)

3 -- Family name

Indicator 2 undefined.

Indicator 2 became obsolete in 1990. Older records may display 0 or 1

Subfields used most often:

\$a -- Personal name

\$b -- Numeration

\$c -- Titles and other words associated with a name (R)

\$q -- Fuller form of name

\$d -- Dates associated with a name (generally, year of birth)

Example: 100 1# \$a Gregory, Ruth W.
 \$q (Ruth Wilhelme),
 \$d 1910-

130 Main entry -- Uniform title -- (NR)

Indicator 1: Nonfiling characters

0-9 -- Number of nonfiling characters present (for initial articles, including spaces)

Indicator 2 undefined.

Indicator 2 became obsolete in 1990. (See 100 above.)

Subfields used most often:

\$a -- Uniform title

\$p -- Name of part/section of a work (R)

\$l -- Language of a work

\$s -- Version

\$f -- Date of a work

Example: 130 0# \$a Bible.
 \$p O.T.
 \$p Psalms.

240 Uniform title (NR)

Indicator 1: Uniform title printed or displayed

0 -- Not printed or displayed

1 -- Printed or displayed (most common)

Indicator 2: Nonfiling characters

0-9 -- Number of nonfiling characters present (for initial articles, including spaces)

Subfields used most often:

\$a -- Uniform title

\$l -- Language of a work

\$f -- Date of a work

Example: 240 10 \$a Ile mystérieuse.
 \$l English.
 \$f 1978

245 Title Statement (NR)

Indicator 1: Title added entry

(Should the title be indexed as a title added entry?)

0 -- No title added entry

(indicates a title main entry; i.e. no author is given)

1 -- Title added entry

(the proper indicator when an author given in 1XX; the most common situation)

Indicator 2: Nonfiling characters

0-9 -- Number of nonfiling characters present, including spaces; usually set at zero, except when the title begins with an article; e.g., for *The robe*, the second indicator would be set to 4. The letters *T*, *h*, *e*, and the space following them are then ignored in alphabetizing titles. The record will be automatically filed under "*r*" -- for *Robe*.

Subfields used most often:

\$a -- Title proper

\$h -- Medium (often used for non-book media)

\$p -- Name of part/section of a work (R)

\$b -- Reminder of title (subtitles, etc.)

\$c -- Remainder of title page transcription/Statement of responsibility

Example: 245 14 \$a The DNA story :
 \$b a documentary history of gene
 cloning /
 \$c James D. Watson, John Tooze.

246 Varying form of title (R)

Indicator 1: Note/title added entry controller

1 -- Note, title added entry

3 -- No note, title added entry

Indicator 2: Type of title

-- No information provided

0 -- Portion of title

1 -- Parallel title

4 -- Cover title

8 -- Spine title

Subfield used most often:

\$a -- Title proper

Example: 246 3# \$a Four corners power review

250 Edition statement (NR)

Indicators undefined.

Subfield used most often:

\$a -- Edition statement

Example: 250 ## \$a 6th ed.

260 Publication, distribution, etc. (Imprint) (R)

Indicator 1: Sequence of publishing statements

-- No information provided

Indicator 2: Undefined

Subfields used most often:

\$a -- Place of publication, distribution, etc. (R)

\$b -- Name of publisher, distributor, etc. (R)

\$c -- Date of publication, distribution, etc. (R)

Example: 260 ## \$a New York :
 \$b Chelsea House,
 \$c 1986.

300 Physical description (R)

Indicators undefined.

Subfields used most often:

\$a -- Extent (number of pages) (R)

\$b -- Other physical details (usually illustration information)

\$c -- Dimensions (cm.) (R)

\$e -- Accompanying material (for example, "teacher's guide" or "manual")

Example: 300 ## \$a 139 p. :
 \$b ill. ;
 \$c 24 cm.

440 Series statement / Added entry--Title

This field was made obsolete in 2008 to simplify the series statement. See 490 and 830.

490 Series statement (No added entry is traced from field) (R)

Indicator 1: Specifies whether series is traced (whether an 8XX tag is also present)

0 -- Series not traced

1 -- Series traced (8XX is in record)

Indicator 2 undefined.

Subfield used most often:

\$a -- Series statement (R)

\$v -- Volume number (R)

Example: 490 1# \$a Colonial American craftsmen

500 General note (R)

Indicators undefined.

Subfield used most often:

\$a -- General note (Used when no specialized note field has been defined for the information. Examples: Notes regarding the index; the source of the title; variations in title; descriptions of the nature, form, or scope of the item.)

Example: 500 ## \$a Includes index.

504 Bibliography, etc. note (R)

\$a -- Bibliography, etc. note

600 Subject added entry -- Personal name (R)*Indicator 1:* Type of personal name entry element

0 -- Forename

1 -- Surname (this is the most common form)

3 -- Family name

Indicator 2: Subject heading system/thesaurus (identifies the specific list or file which was used)

0 -- Library of Congress Subject Headings

1 -- LC subject headings for children's literature

2 -- Medical Subject Headings

3 -- National Agricultural Library subject authority file

4 -- Source not specified

5 -- Canadian Subject Headings

6 -- Répertoire de vedettes-matière

7 -- Source specified in subfield \$2

(Note regarding Sears subject headings: The MARC 21 format does not provide an assigned indicator for Sears subject headings. Therefore, an indicator of 7 is used, and the MARC defined code "sears" is placed in subfield \$2.)

*Subfields used most often:***\$a** -- Personal name (surname and forename)**\$b** -- Numeration**\$c** -- Titles and other words associated with a name (R)**\$q** -- Fuller form of name**\$d** -- Dates associated with a name (generally, year of birth)**\$t** -- Title of a work**\$v** -- Form subdivision (R)**\$x** -- General subdivision (R)**\$y** -- Chronological subdivision (R)**\$z** -- Geographic subdivision (R)**\$2** -- Source of heading or term (used with 2nd indicator of 7)

Example: 600 10 \$a Shakespeare, William,
 \$d 1564-1616
 \$x Comedies
 \$x Stage history.

Example: 600 10 \$a Shakespeare, William,
 \$d 1564-1616
 \$x Knowledge

\$z Rome \$v Congresses.

Notice that subfields \$v, \$x, and \$z in the 600 field are repeatable. Subfields \$v, \$x, \$y, and \$z do not have to be in alphabetical order. They will be in the order prescribed by the instructions given by the subject heading system.

610 Subject added entry -- Corporate name (R)

Indicator 1: Type of corporate name entry element

0 -- Inverted name (not used with AACR2)

1 -- Jurisdiction name

2 -- Name in direct order

Indicator 2: Subject heading system/thesaurus.

See indicator 2 under 600

Subfields used most often:

\$a -- Corporate name or jurisdiction name as entry element

\$b -- Subordinate unit (R)

\$v -- Form subdivision (R)

\$x -- General subdivision (R)

\$y -- Chronological subdivision (R)

\$z -- Geographic subdivision (R)

\$2 -- Source of heading or term (used with 2nd indicator of 7)

<i>Example:</i> 610 10 \$a United States. \$b Army Air Forces \$v Biography.
--

650 Subject added entry -- Topical term (Most subject headings fit here.) (R)

Indicator 1: Level of subject

-- No information provided

Indicator 2: Subject heading system/thesaurus

(identifies the specific list or file which was used)

0 -- Library of Congress Subject Headings

1 -- LC subject headings for children's literature

2 -- Medical Subject Headings

3 -- National Agricultural Library subject authority file

4 -- Source not specified

5 -- Canadian Subject Headings

6 -- Répertoire de vedettes-matière

7 -- Source specified in subfield \$2

Note regarding Sears subject headings: The MARC 21 format does not provide an assigned indicator for Sears subject headings. Therefore, an indicator of 7 is used, and the MARC defined code "sears" is placed in subfield \$2.)

Subfields used most often:

- \$a -- Topical term
- \$v -- Form subdivision (R)
- \$x -- General subdivision (R)
- \$y -- Chronological subdivision (R)
- \$z -- Geographic subdivision (R)
- \$2 -- Source of heading or term used with 2nd indicator of 7)

Example: 650 #0 \$a Theater
 \$z United States
 \$v Biography
 \$v Dictionaries.

Notice that subfields \$v, \$x, and \$z in the 650 field are repeatable. Subfields \$v, \$x, \$y, and \$z do not have to be in alphabetical order. They will be in the order prescribed by the instructions given by the subject heading system.

651 Subject added entry -- Geographic name (R)

Indicator 1: undefined.

Indicator 2: Subject heading system/thesaurus.

See indicator 2 under 600

Subfields used most often:

- \$a -- Geographic name
- \$v -- Form subdivision (R)
- \$x -- General subdivision (R)
- \$y -- Chronological subdivision (R)
- \$z -- Geographic subdivision (R)
- \$2 -- Source of heading or term (used with 2nd indicator of 7)

Example: 651 #0 \$a United States
 \$x History
 \$v Chronology.

Notice that subfields \$v, \$x, and \$z in the 651 field are repeatable. Subfields \$v, \$x, \$y, and \$z do not have to be in alphabetical order. They will be in the order prescribed by the instructions given by the subject heading system.

700 Added entry -- Personal name (R)

Indicator 1: Type of personal name entry element

0 -- Forename

1 -- Surname (this is the most common form)

3 -- Family name

Indicator 2: Type of added entry

-- No information provided (most common; co-authors, editors, etc.)

2 -- Analytical entry (The values for Indicator 2 changed in 1994 with Format Integration, and older records may display additional values. An analytical entry involves an author/title of an item contained in a work.)

Subfields used most often:

\$a -- Personal name

\$b -- Numeration

\$c -- Titles and other words associated with a name (R)

\$q -- Fuller form of name

\$d -- Dates associated with a name (generally, year of birth)

\$e -- Relator term (such as ill.) (R)

\$4 -- Relator code (R)

Example: 700 1# \$a Baldridge, Letitia.

710 Added entry -- Corporate name (R)

Indicator 1: Type of corporate name entry element

0 -- Inverted name (not used with AACR2)

1 -- Jurisdiction name

2 -- Name in direct order

Indicator 2: Type of added entry.

See Indicator 2 under 700

-- No information provided

2 -- Analytical entry

Subfields used most often:

\$a -- Corporate name or jurisdiction name as entry element

\$b -- Subordinate unit (R)

Example: 710 2# \$a Sunburst Communications (Firm)

740 Added entry -- Uncontrolled related/analytical title (R)

Indicator 1: Nonfiling characters

0-9 -- Number of nonfiling characters present (for initial articles, including spaces)

Indicator 2: Type of added entry. See Indicator 2 under 700

-- No information provided

2 -- Analytical entry

(This field was redefined in 1994 with Format Integration. Prior to 1994, the field was also used for variant titles, such as a different wording on a spine title. In records created since Format Integration, those variant titles appear in a 246 field.)

Subfield used most often:

\$a -- Title

Example: 740 02 \$a Uncle Vanya.

800 Series added entry -- Personal name (R)

Indicator 1: Type of personal name entry element

0 -- Forename

1 -- Surname

3 -- Family name

Indicator 2 undefined.

Subfields used most often:

\$a -- Personal name

\$b -- Numeration

\$c -- Titles and other words associated with a name (R)

\$q -- Fuller form of name

\$d -- Dates associated with a name (generally, year of birth)

\$t -- Title of a work (the series)

\$v -- Volume number

Example: 800 1# \$a Fisher, Leonard Everett.
 \$t Colonial American craftsmen.

830 Series added entry -- Uniform title (R)

Indicator 1 undefined.

Indicator 2: Nonfiling characters

0-9 -- Number of nonfiling characters present (for initial articles, including spaces)

Subfield used most often:

\$a -- Uniform title

\$v -- Volume number

Example: 830 #0 \$a Railroads of America (Macmillan)

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Part VIII:

A List of Other Fields Often Seen in MARC Records

001	Control number
003	Control number identifier
005	Date and time of latest transaction
006	Fixed-length data elements -- additional material characteristics
007	Physical description fixed field
008	Fixed length data elements (See Part X)
022	International Standard Serial Number (ISSN)
037	Source of acquisition
041	Language code
043	Geographic area code
050	Library of Congress call number
060	National Library of Medicine call number
082	Dewey Decimal classification number (the one recommended by the Library of Congress; locally-assigned call numbers may appear elsewhere)
110	Main entry -- Corporate name (less frequent under AACR2 rules)
256	Computer file characteristics
263	Projected publication date (indicates a CIP -- Cataloging in Publication -- record)
306	Playing time
508	Creation/production credits note
510	Citation/references note (review sources)
511	Participant or performer note
521	Target audience note (first indicator: 0 = reading grade level, 1 = interest age level, 2 = interest grade level, 3 = special audience characteristics, 4 = motivation interest level)
530	Additional physical form available note
538	System details note
586	Awards note
656	Index term -- Occupation
730	Added entry -- Uniform title
852	Location

- 856 Electronic location and access
 9XX Reserved for local use. (They are used by vendors, systems, or individual libraries to exchange additional data)

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Part IX:

The Leader

There are 24 positions in the Leader, numbered from 00 to 23. For fuller explanation, see the *MARC 21 Format for Bibliographic Data*.

- 00-04 Record length (calculated by the computer for each record)
 05 Record status
 a = increase in encoding level
 c = corrected or revised
 d = deleted
 n = new
 p = increase in encoding from prepublication (previous CIP)
 06 Type of record
 a = language material
 c = printed music
 d = manuscript music
 e = cartographic material
 f = manuscript cartographic material
 g = projected medium
 i = nonmusical sound recording
 j = musical sound recording
 k = 2-dimensional nonprojectable graphic
 m = computer file
 o = kit
 p = mixed materials
 r = 3-dimensional artifact or naturally occurring object
 t = manuscript language material
 07 Bibliographic level
 a = monographic component part
 b = serial component part
 c = collection
 d = subunit
 i = integrating resource
 m = monograph/item
 s = serial
 08 Type of control
 # = no specified type
 a = archival

- 09 **Character coding scheme**
 # = MARC-8
 a = UCS/Unicode
- 10 **Indicator count** (always "2")
- 11 **Subfield code count** (always "2")
- 12-16 **Base address of data** (calculated by the computer for each record)
- 17 **Encoding level**
 # = full level
 1 = full level, material not examined
 2 = less-than-full level, material not examined
 3 = abbreviated level
 4 = core level
 5 = partial (preliminary) level
 7 = minimal level
 8 = prepublication level (CIP)
 u = unknown
 z = not applicable
- 18 **Descriptive cataloging form**
 # = non-ISBD
 a = AACR2
 i = ISBD
 u = unknown
- 19 **Multipart resource record level**
 # = Not specified or not applicable
 a = Set
 b = Part with independent title
 c = Part with dependent title
- 20 **Length of the length-of-field portion** (always "4")
- 21 **Length of the starting-character-position portion** (always "5")
- 22 **Length of the implementation-defined portion** (always "0")
- 23 **Undefined** (always "0")

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Part X:

Field 008 for Books

Field 008 is used for Fixed Length Data Elements ("Fixed Field Codes"). There are 40 character positions in field 008, numbered from 00-39. Undefined positions must contain either a blank (#) or a fill character (|). Positions 00-17 and 35-39 are defined the same way for all media.

The information shown here for positions 18-34 applies only to books. For explanation of all the positions below and for positions 18-34 for other media, see the *MARC 21 Format*

for Bibliographic Data.

Note that field 008 has no indicators or subfield codes.

- 00-05 Date entered on file (YYMMDD),
 where Y=year, M=month, and D=day
- 06 Type of date/publication status:
 b = no dates given; B.C. date involved
 e = detailed date
 s = single known date/probable date
 m = multiple dates
 r = reprint/reissue date (Date 1) and original date (Date 2)
 n = dates unknown
 q = questionable date
 t = publication date and copyright date
 | = no attempt to code
- 07-10 Date 1/beginning date of publication
- 11-14 Date 2/ending date of publication

Date fields contain the year(s) of publication. The type of date(s) in these elements are specified in fixed field element 06: Type of date/publication status. (For further details, see the field 008 description in the *MARC 21 Format for Bibliographic Data*.)

- 15-17 Place of publication, production, or execution
 For example:
 pk# = Pakistan
 cau = California (US)

(For a full list of codes used in these positions, see the [MARC Code List for Countries](#).)

- 18-21 Illustrations (up to 4 codes):
 # = no illustrations
 a = illustrations
 b = maps
 c = portraits
 d = charts
 e = plans
 f = plates
 g = music
 h = facsimiles
 i = coats of arms
 j = genealogical tables
 k = forms
 l = samples
 m = phonodisc, phonowire, etc.
 o = photographs
 p = illuminations
 | = no attempt to code

- 22 **Target audience:**
= unknown or not specified
a = preschool
b = primary
c = pre-adolescent
d = adolescent
e = adult
f = specialized
g = general
j = juvenile
| = no attempt to code
- 23 **Form of item:**
= none of the following
a = microfilm
b = microfiche
c = microopaque
d = large print
f = braille
r = regular print reproduction
s = electronic
| = no attempt to code
- 24-27 **Nature of contents (up to 4):**
= no specified nature of contents
a = abstracts/summaries
b = bibliographies (is one or contains one)
c = catalogs
d = dictionaries
e = encyclopedias
f = handbooks
g = legal articles
i = indexes
j = patent document
k = discographies
l = legislation
m = theses
n = surveys of literature
o = reviews
p = programmed texts
q = filmographies
r = directories
s = statistics
t = technical reports
u = standards/specifications
v = legal cases and notes
w = law reports and digests
z = treaties
| = no attempt to code

- 28 **Government publication:**
= not a government publication
i = international intergovernmental
f = federal/national
a = autonomous or semi-autonomous component
s = state, provincial, territorial, dependent, etc.
m = multistate
c = multilocal
l = local
z = other type of government publication
o = government publication -- level undetermined
u = unknown if item is government publication
| = no attempt to code
- 29 **Conference publication:**
0 = not a conference publication
1 = conference publication
| = no attempt to code
- 30 **Festschrift:**
0 = not a festschrift
1 = festschrift
| = no attempt to code
- 31 **Index:**
0 = no index
1 = index present
| = no attempt to code
- 32 **Undefined (since 1990)** (Earlier records may contain the values 0 or 1)
= Undefined
| = no attempt to code
- 33 **Literary form:**
0 = not fiction (not further specified)
1 = fiction (not further specified)
c = comic strips
d = dramas
e = essays
f = novels
h = humor, satires, etc.
i = letters
j = short stories
m = mixed forms
p = poetry
s = speeches
u = unknown
| = no attempt to code
- 34 **Biography:**
= no biographical material
a = autobiography
b = individual biography

- c = collective biography
- d = contains biographical information
- | = no attempt to code

35-37 Language:

A three-letter code. For example: eng fre ger spa rus ita

(For a full list of codes used in these positions, see the [MARC Code List for Languages](#).)

38 Modified record:

- # = not modified
- x = missing characters (because of characters unavailable in MARC character set)
- s = shortened
- d = "dashed-on" information omitted
- r = completely romanized/printed cards in script
- o = completely romanized/printed cards romanized
- | = no attempt to code

39 Cataloging source:

- # = national bibliographic agency
- c = cooperative cataloging program
- d = other sources
- u = unknown
- | = no attempt to code

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Exhibit 1010

PILOT ASSISTED CHANNEL ESTIMATION FOR OFDM IN MOBILE CELLULAR SYSTEMS

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Abstract — The use of pilot symbols for channel estimation introduces overhead and it is thus desirable to keep the number of pilot symbols to a minimum. The number of needed pilot symbols for a desired bit error rate and Doppler frequency is highly dependent on the pilot pattern used in orthogonal frequency division multiplexed, OFDM, systems. Five different pilot patterns are analysed by means of resulting bit error rate, which is derived from channel statistics. Rearrangement of the pilot pattern enables a reduction in the number of needed pilot symbols up to a factor 10, still retaining the same performance. The analysis is general and can be used for performance analysis and design of pilot patterns for any OFDM system.

I. INTRODUCTION

The mobile channel introduces multipath distortion of the signalling waveforms. Both the amplitude and phase are corrupted and the channel characteristics changes because of movements of the mobile. In order to perform coherent detection, reliable channel estimates are required. These can be obtained by occasionally transmitting known data or so called "pilot symbols". The receiver interpolates the channel information derived from the pilots to obtain the channel estimate for the data signal, see Fig. 1.

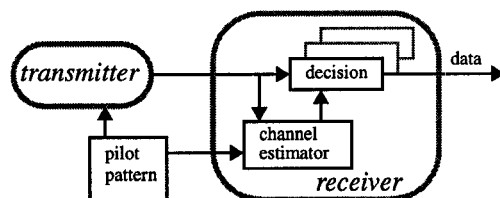


Fig. 1 The pilot pattern is known both by the receiver and the transmitter. The purpose is to minimize the number of transmitted pilot symbols without increasing the bit error rate.

OFDM, orthogonal frequency division multiplexing, is used and proposed for several broadcast systems and there is a growing interest in using the technique for the next generation land mobile communication system. In OFDM systems the information signal can be seen as divided and transmitted by several narrowband sub-carriers. Typically, for practical OFDM systems, the frequency spacing is less than the coherence bandwidth and the symbol time is less than the coherence time. This means that a receiver and pilot estimation pattern that take advantage of the relatively large coherence bandwidth and coherence time can manage with less pilot symbols, thereby minimizing the overhead introduced by the pilot symbols. The problem is to decide where and how often to insert pilot symbols. The spacing between the pilot symbols shall be

chosen small enough to enable reliable channel estimates but large enough not to increase the overhead too much. This paper includes among all an algorithm of how to design a suitable pilot estimation pattern.

In a multicarrier system there exist a unique opportunity to determine various parts of the channel impulse response, as opposed to a single-carrier system. It is no use to make efforts to determine already known parts. Until now it seems like no one has looked into the impact of the placement of the pilot symbols for multicarrier systems. Cavers [5] made an exhaustive theoretical analysis for single-carrier systems. He pointed out that it was appropriate that 14% of the sent symbols were pilot symbols to be able to handle large Doppler values ($f_d T_s = 0.05$). Some pilot estimation patterns for OFDM has been presented in the literature, see e.g. [6], [7]. Comparisons between these and the one proposed here are shown later.

II. ESTIMATION STRATEGIES

Five different pilot patterns are analyzed, see Fig. 2.

1. Measure all channels at the same time, compare to a broad-band single-carrier system.
2. Measure the channels in increasing order, one at a time.
3. Measure the channels one at a time in a smart, but predetermined, way. The measurement order is derived upon channel statistics and is optimal in the sense that the total bit error rate is kept at a minimum each symbol time.
4. A pilot pattern presented by T. Mueller *et al.* [6], where the pilots are located with equidistant spacings in time and frequency.
5. A pilot pattern by P. Hoeher [7], used in [4]. The pilot symbol locations are shifted one step in frequency each pilot interval.

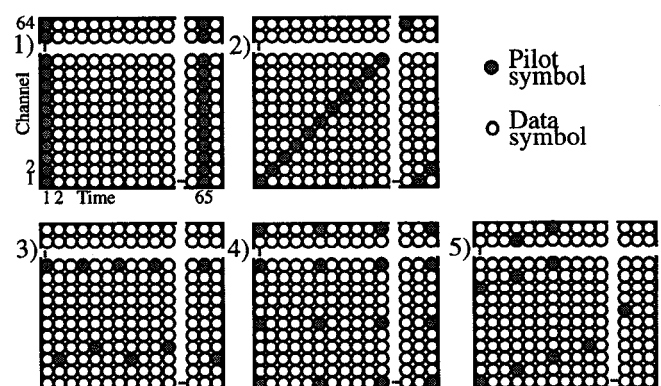


Fig. 2 Examples of pilot patterns analyzed.

For comparison the same amount of pilots is used, one of 64 sent symbols. This means that only 1.6% extra overhead is introduced by the pilots, but this is not sufficient for large Doppler frequencies in some of the cases.

III. SYSTEM

At different signal to noise ratios the resulting bit error rate from each pilot pattern is evaluated using the algorithms given in Section VIII. A matched filter receiver and coherent BPSK or QPSK are used. Additive white Gaussian noise is assumed for every sub-channel. The channel has delays and Rayleigh distributed amplitudes according to the COST 207: "Typical Urban profile". The complex parts of the transfer function are assumed to change according to a first order auto-regressive process as described in Section VI. The reason for using this model is to get a linear system which rather easy can be handled algebraically. A Kalman filter is used to estimate the frequency response of the channel. From the filter, a time dependent covariance matrix is given as described in Section VII. This is used to calculate the expected bit error rate for each channel. See Fig. 3 for a description of the system.

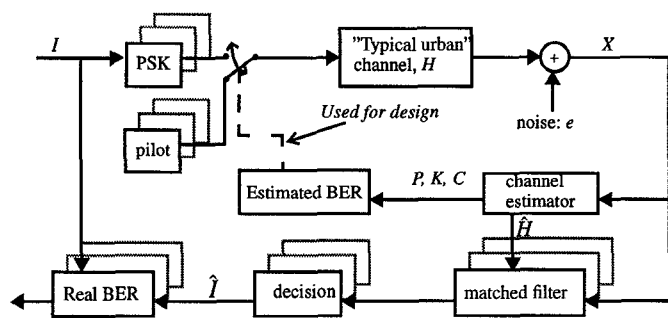


Fig. 3 Overview of the system used to analyze the estimation patterns.

IV. RESULTS

The resulting bit error rate curves of the pilot patterns are presented for different Doppler frequencies in Fig. 4.

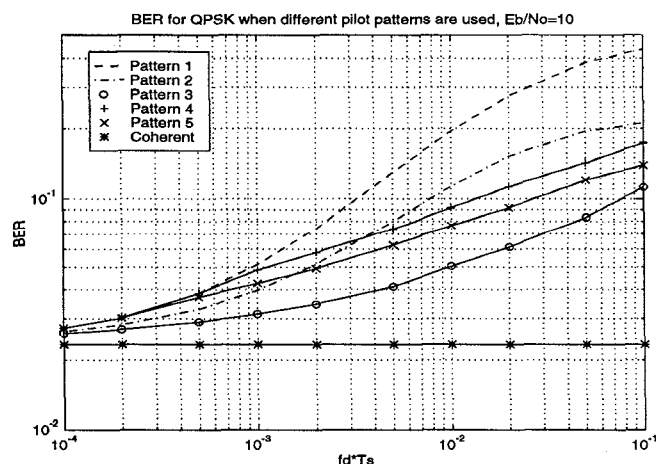


Fig. 4 Resulting bit error rate as a function of Doppler value when the different pilot patterns are used. The same number of pilot symbols are used for all curves.

For a given Doppler frequency the pilot pattern used sets the limit for the lowest pilot density to be used, alternatively for a given pilot density it limits the maximum Doppler frequency allowed. The calculations are made at 1800 MHz using 10 kHz channel separation between 64 OFDM channels carrying in total 640 ksymbols/s. No intersymbol interference, perfect synchronization and known Doppler frequency, f_d , is assumed. 1.6% of the sent symbols are pilot symbols and the average bit error rate of the 64 channels is presented.

The bit error rate is degraded both by imperfect channel estimates and noise disturbances. The pilot pattern used determines the conversion between noise limited and estimate limited region, see Fig. 5.

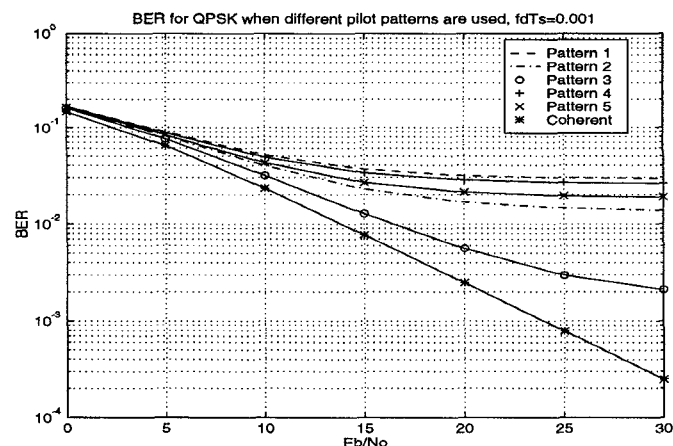


Fig. 5 Bit error rate at different signal to noise ratios. Note the difference between the error floors.

It is interesting to study the resulting pattern when estimating the channel that gives the lowest bit error rate (strategy 3). A steady state pilot pattern is often achieved where only few of the sub-channels are measured, see Fig. 6. Channel estimates of the other sub-channels are achieved by filtering.

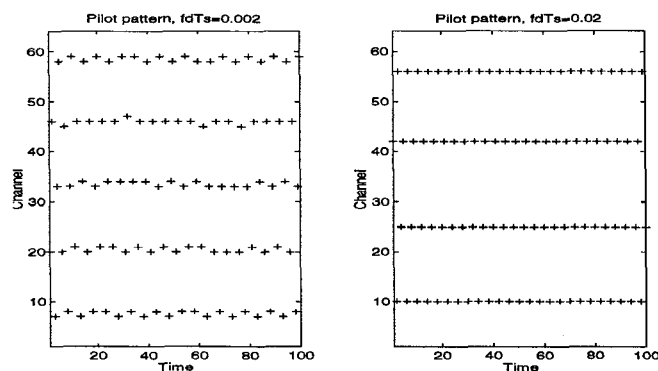


Fig. 6 Resulting pilot pattern when sending a pilot at the channel which gives the lowest total bit error rate. Note that only few channels will be used for pilot symbols.

To see the effect of mismatch between the pilot pattern design parameters and the actual parameters, the optimal pilot patterns (pattern 3) for three Doppler values were used when moving at another speed. The actual Doppler frequency was as before assumed to be known by the estimator, just to see the effect of the pilot pattern without influences of the estimation algorithm. The designed pilot patterns for the "typical urban" environment were also used in "hilly terrain" and "rural area"

specified in [2] to see the influence of the propagation environment on the bit error rate, see Fig. 7.

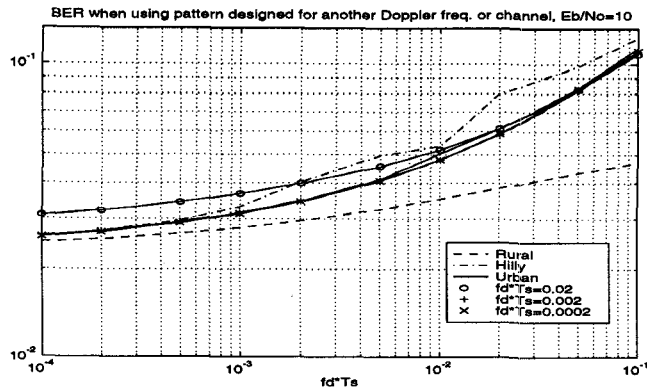


Fig. 7 Changes in the bit error rate due to Doppler mismatch and power delay profile mismatch. The pilot patterns designed for $f_d T_s = 0.02, 0.002$ and 0.0002 were used at different Doppler values and the designed patterns for typical urban environment were used in hilly terrain and rural area.

As seen in the figure, the pilot patterns are robust to mismatches in the design parameters.

V. DISCUSSION

To minimize the bit error rate it is desirable to spread the pilot symbols both in time and in frequency, as seen in Fig. 4 and Fig. 5. Normally a worst case design is made for the channel estimation system and then we suggest to tailor the pilot pattern to each base station site. A suitable pilot pattern can be calculated once the propagation environment and maximum expected speed in the particular cell is known. In such a system, the pilot pattern used in the cell is among the information transferred to the mobile when it logs into a new cell. When designing the pilot pattern one also has to take the estimation algorithm into account. Here the estimation algorithm is used only for evaluation and the complexity of the used algorithm is not a problem. In some cases the pilot pattern has to aid the estimation algorithm to enable a less complex one. The estimation algorithm used here, the Kalman filter based on an AR-process, has no delay and the received signal can be detected immediately, i.e. no future pilot symbols is taken into account when making the channel estimate. If the received signal is stored in a memory, the pilot symbols can be used in both "time directions" and the time spacings between pilot symbols can be increased, retaining the same performance.

The degradation due to mismatch in design parameters is mainly caused by the estimation algorithm and therefore the curves for different Doppler values do not differ much. When the pilot pattern is designed for higher Doppler values than the actual one, an increased error rate is achieved since the pilot symbols are not located as close to each other in frequency as desired. In rural area the bit error rate becomes lower due to the increased frequency correlation while the opposite happens in hilly terrain. In the first case, an even better result is achieved with less pilots along the frequency axes and more along the time axes.

The bit error rates within the sub-channels differ depending on where the pilots are located. When minimizing the total bit error rate (pattern 3) the channels of the sides get higher error rate, see example in Fig. 8.

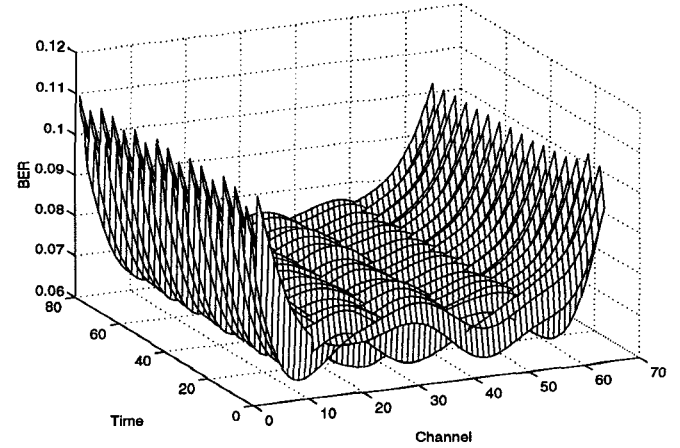


Fig. 8 The bit error rate becomes higher for the side channels when the total bit error rate is kept at a minimum

VI. CHANNEL MODEL

The time dependent impulse response, $h(\tau, t)$, is assumed to be a sum of reflections, see (1) where $\delta(t)$ denotes the dirac-function.

$$h(\tau, t) = \sum_{n=1}^N a_n(t) \cdot \delta(t - \tau_n) \quad (1)$$

The tap coefficients, $a_n(t)$, and the tap delays, τ_n , are chosen according to the COST 207 "Typical Urban" model in the GSM specification [2]. The transfer functions, $H(f, t)$, are obtained by the Fourier transform and these are the functions we want to estimate for the different carriers. These channel transfer functions are regarded as flat fading and constant during a symbol time.

A first order AR-process is used to model how the different taps may change from one time instant to another. If we look at all the transfer functions at the same time, it is possible to set up a state-space model of the form:

$$\begin{aligned} H(k+1) &= \phi H(k) + v(k) \\ y(k) &= C(k)H(k) + e(k) \end{aligned} \quad (2)$$

The matrix ϕ is a diagonal $N \times N$ -matrix (here treated as a scalar) with elements

$$e^{-k_{AR} 2\pi f_d T_s} \quad (3)$$

that define the AR-process. T_s is the symbol time including any cyclic prefix or guard space. The white noise $v(k)$ has covariance matrix $R_1 = F \cdot R_{GSM} \cdot F^*$, where R_{GSM} corresponds to the multipath intensity profile described in [2]. The vector $y(k)$ is the measured transfer functions. $C(k)$ is an observation vector with ones only at the positions (channels) measured at time KT_s and $e(k)$ is measurement noise with a diagonal covariance matrix R_2 .

The parameter k_{AR} in the auto-regressive process for the channel changes is chosen to adjust the "memory" so that it

corresponds to the "memory" of Jakes' model. Channels corresponding to the U-shaped spectrum given in [8] were simulated and then estimators based on an AR-model with different k_{AR} were used, see Fig. 9

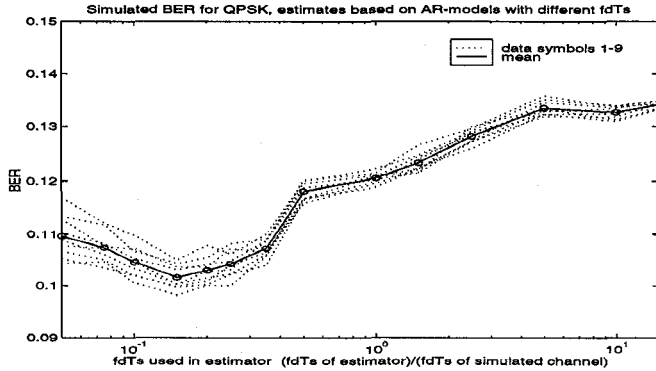


Fig. 9 Bit error rate for a simulated channel by Jakes when estimates are based on an AR-process. The minimum value is reached for $k_{AR}=0.15$.

Simulations were performed with one sub-channel ($E_b/N_o = 10$, $f_d T_s = 0.002$) with every tenth symbol as a pilot symbol. In the figure the bit error rates of the nine data symbols are shown. Fig. 9 shows that the best fit, in this case, is reached for $k_{AR} \approx 0.15$.

The adjustment of the AR-process can also be seen as an adjustment of the bandwidth. If we set the 90% power bandwidth of the AR process equal to the bandwidth of the Doppler spread, see Fig. 10, a value of $k_{AR} \approx 0.158$ can be calculated. This is the value used for all bit error rate calculations throughout the paper.

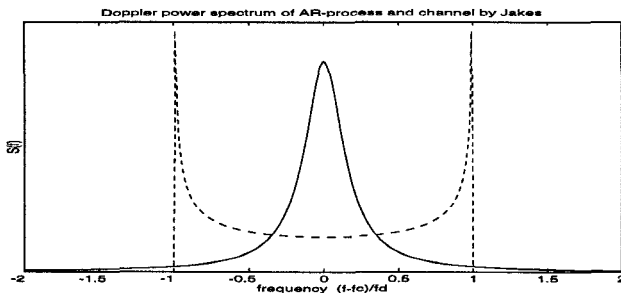


Fig. 10 Power density spectrum of the channel by Jakes and a first order AR-process. The latter is adjusted to have the 90% power bandwidth equal to the Doppler spread.

VII. CHANNEL ESTIMATOR

For the analysis and pilot pattern design a Kalman filter is used to estimate the transfer functions. The Kalman filter is causal and uses measurements up to time k to estimate the transfer functions, $H(k)$. The Kalman filter is given [3] by (4)-(8), where X^* denotes conjugate transpose of X :

$$\hat{H}(k|k) = \hat{H}(k|k-1) + P(k|k-1)C(k)^* \cdot \{C(k)P(k|k-1)C(k)^* + R_2\}^{-1} (y(k) - C(k)\hat{H}(k|k-1)) \quad (4)$$

$$\begin{aligned} \hat{H}(k+1|k) &= \phi \hat{H}(k|k-1) + \\ K(k)[y(k) - C(k)\hat{H}(k|k-1)] &= \phi \hat{H}(k|k) \end{aligned} \quad (5)$$

$$K(k) = \phi P(k|k-1)C(k)^* \cdot [C(k)P(k|k-1)C(k)^* + R_2]^{-1} \quad (6)$$

$$P(k+1|k) = \phi P(k|k-1)\phi^* + R_1 - K(k)[C(k)P(k|k-1)C(k)^* + R_2]K(k)^* \quad (7)$$

$$P(k|k) = P(k|k-1) - P(k|k-1)C(k)^* \cdot [C(k)P(k|k-1)C(k)^* + R_2]^{-1} C(k)P(k|k-1) \quad (8)$$

The reconstruction error $\tilde{H}(k|k) = H(k) - \hat{H}(k|k)$ is given by:

$$\begin{aligned} \tilde{H}(k|k) &= [\phi - K(k)C(k)]\tilde{H}(k-1|k-1) + v(k-1) - \\ P(k|k-1)C(k)^* [C(k)P(k|k-1)C(k)^* + R_2]^{-1} \cdot \{e(k) + C(k)v(k-1)\} \end{aligned} \quad (9)$$

The Kalman filter is optimal in the sense that the variance of the reconstruction error is minimized. The matrix $P(k|k)$ is the variance matrix and this is used together with K to make an estimate of the bit error rate, which in turn is used to decide the order in which the channels are going to be measured. For pattern 3, the channel is chosen that minimizes the total bit error rate of the channels after the measurement. The matrices $P(k|k)$ and K are independent of the measured values and therefore it is possible to precompute the order in which the channels are going to be measured.

VIII. BIT ERROR RATE CALCULATIONS

The bit error rate is calculated for BPSK and QPSK. A matched filter receiver is assumed. The sampled output of this filter is given by

$$X_m = 2\epsilon H_m e^{j\frac{2\pi}{M}(n-1)} + e_m \quad (10)$$

where ϵ is the signal energy, H_m is the current transfer function at channel m , n is the signal alternative among M sent and e_m is white gaussian noise. The bit error rate at channel m is calculated as [1]

$$\begin{aligned} P_{bmBPSK} &= \frac{1}{2}(1 - \mu_m) \\ P_{bmQPSK} &= \frac{1}{2} \left(1 - \frac{\mu_m}{\sqrt{2 - \mu_m^2}} \right) \end{aligned} \quad (11)$$

where

$$\mu_m = \frac{E[X_m \hat{H}_m^*]}{\sqrt{E[|X_m|^2]E[|\hat{H}_m|^2]}} \quad (12)$$

$\hat{H}_m$ are the outputs of the Kalman filter. These are not known in advance and therefore (13) - (15) are used. If matrix notation is used and signal alternative 1 is used for the pilot symbol (does affect the analysis here, but in practise different pilot symbol alternatives should be used), the expectations for all the channels can be calculated as:

$$\begin{aligned}
E[X(k)\hat{H}(k)^*] & \quad (13) \\
&= E[\{2\epsilon H(k) + N(k)\}\{H(k) - \tilde{H}(k)\}^*] \\
&= 2\epsilon E[H(k)H(k)^*] - 2\epsilon E[H(k)\tilde{H}(k)^*]
\end{aligned}$$

$$\begin{aligned}
E[|X(k)|^2] &= E[\{2\epsilon H(k) + N(k)\}\{2\epsilon H(k) + N(k)\}^*] \quad (14) \\
&= 4\epsilon^2 E[H(k)H(k)^*] + E[N(k)N(k)^*]
\end{aligned}$$

$$\begin{aligned}
E[|\hat{H}(k)|^2] &= E[\{H(k) - \tilde{H}(k)\}\{H(k) - \tilde{H}(k)\}^*] \quad (15) \\
&= E[H(k)H(k)^*] - 2E[H(k)\tilde{H}(k)^*] + E[\tilde{H}(k)\tilde{H}(k)^*]
\end{aligned}$$

The expected values $E[X(k)\hat{H}(k)^*]$, $E[|X(k)|^2]$ and $E[|\hat{H}(k)|^2]$ are independent of the measured values but dependent upon which channels that are measured. Therefore they are time dependent. The expectations can be calculated as:

$$\begin{aligned}
E[H(k)H(k)^*] & \quad (16) \\
&= E[\{\phi H(k-1) + v(k-1)\}\{\phi H(k-1) + v(k-1)\}^*] \\
&= \phi^2 E[H(k-1)H(k-1)^*] + E[v(k-1)v(k-1)^*] \\
&= R_1/(1-\phi^2)
\end{aligned}$$

$$E[N(k)N(k)^*] = R_2 \quad (17)$$

$$\begin{aligned}
E[H(k)\tilde{H}(k)^*] &= E[H(k)H(k)^* - H(k)\hat{H}(k)^*] \quad (18) \\
&= E[\phi H(k-1)\tilde{H}(k-1)^*\phi^* + R_1 - R_1 C(k)^*a^* \\
&\quad - \phi H(k-1)\tilde{H}(k-1)^*\phi^* C(k)^*a^*] \\
&= (\phi E[H(k-1)\tilde{H}(k-1)^*]\phi^* + R_1)(I - C(k)^*a^*)
\end{aligned}$$

where

$$E[\tilde{H}(k|k)\tilde{H}(k|k)^*] = P(k|k) \quad (19)$$

$$a = P(k|k-1)C(k)^*\{C(k)P(k|k-1)C(k)^* + R_2\}^{-1} \quad (20)$$

The bit error rate calculation is compared and verified by simulations. Proakis [1] gives expressions for the bit error rate when estimating a constant Rayleigh channel using different numbers of pilot symbols, see Fig. 11.

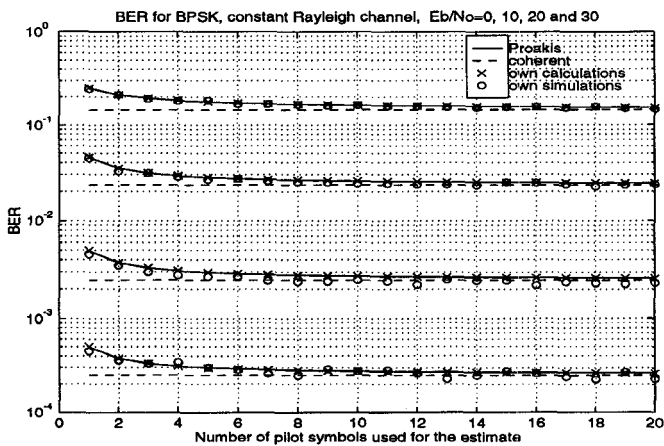


Fig. 11 Bit error rate for 2PSK when estimating a constant Rayleigh channel with several pilot symbols at different signal to noise ratios.

The bit error rate when using only one pilot symbol corresponds to estimating a rapidly changing channel or the first estimate of an unknown channel. Then, only the latest measurement is useful. In a similar way, the bit error rate when

estimating a constant channel with use of (infinitely) many pilot symbols corresponds to that of coherent detection. Normally in a practical system the effect of the estimation is somewhere between these two cases.

IX. CONCLUSIONS

The bit error rate for pilot assisted QPSK modulation is calculated when using different pilot patterns. The ability to estimate the channel reliably when it changes due to e.g. vehicle movements is highly dependent on the pilot pattern used. By rearranging the pilot pattern it is, in some cases, possible to handle 10 times higher Doppler frequency alternatively possible to reduce the number of needed pilot symbols the same amount, still retaining the same bit error rate. Alternatively the new pilot pattern could be used to reduce the bit error rate up to a factor 5, even more in a low noise environment. The pilot symbols in the proposed pilot pattern are spread out both in time and frequency. For a given propagation environment, e.g. a base station site, it is possible to pre-calculate a suitable pilot pattern.

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The use of pilot symbols for channel estimation introduces overhead and it is thus desirable to keep the number of pilot symbols to a minimum. The number of needed pilot symbols for a desired bit error rate and Doppler frequency is highly dependent on the pilot pattern used in orthogonal frequency division multiplexed, OFDM, systems. Five different pilot patterns are analysed by means of resulting bit error rate, which is derived from channel statistics. Rearrangement of the pilot pattern enables a reduction in the number of needed pilot symbols up to a factor 10, still retaining the same performance. The analysis is general and can be used for performance analysis and design of pilot patterns for any OFDM system.

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SOCIETY PRESIDENT'S MESSAGE



On behalf of the Society's Board of Governors, I would like to add our welcome and best wishes for a productive conference. While it is the role of the Board to select the sponsoring Chapter and to provide the initial seed money for each Conference, it is the members of the local chapter who make these events happen. Planning starts as much as five years in advance, and a great deal of personal time, effort and leadership provided by Chapter volunteers is required to produce these conferences for you. From the Board a big and sincere THANK YOU to all. It would be much appreciated if when you see one of these folks you not be bashful about giving him or her a pat on the back.

I would also like to encourage you to take advantage of this opportunity to communicate with some of the Board members you have elected. If you spot one of us let us know if you have any recommendations for improving the society. At least stop and just say Hi. I want to encourage ongoing dialogue with our members and this is one of the few opportunities to chat face-to-face. If we miss you, don't hesitate to e-mail, phone, fax, etc. at anytime.

Now, enjoy Phoenix, and join the excitement which is the essence of our industry and this conference.

Eric Schimmel
1997 President
Vehicular Technology Society

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CONFERENCE CHAIRMAN'S MESSAGE



I would like to personally welcome you to the 47th Annual Vehicular Technology Conference. The Conference Committee, the Valley of the Sun and the Board of Governors of the Vehicular Technology Society have planned a series of outstanding sessions and events that will provide you with a unique opportunity to expand your professional horizons in a robust technical environment and to enjoy a first class experience in the Southwest.

The technical program has been designed to provide participants with a variety of sessions and topics.

Speakers will present leading edge subjects ranging from CDMA and ITS to Satellite Communications. In addition, we are pre-opening the conference on Sunday with over five tutorials and special presentations. This pre-conference program will enable conference participants with an opportunity to "get up to speed" on topics or exchange ideas with presenters addressing subjects that include:

- Spread Spectrum Wireless and IS-95 Digital Cellular Communications
- The TDMA Air Interface for Digital Cellular Radio
- Adaptive Antennas for Wireless Systems
- Narrowband Wireless Multimedia Communications
- Hybrid CDMA Techniques for Universal Mobile Telecommunication Systems and Wireless Multimedia Communications

Thank you in advance for taking advantage of all the conference and the Southwest has to offer.

Michael R. Andrews
Conference Chairman
VTC '97

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TECHNICAL PROGRAM CHAIRMAN'S MESSAGE



Mobile communication systems are being deployed in increasing numbers to link people around the globe. Many global satellite systems are being developed to make instant global communication a reality. The 47th IEEE Vehicular Technology Conference brings you the latest in research and development in mobile communication technology. The theme of this year's conference, "Technology in Motion" is chosen to reflect the ever increasing desire of mankind to keep in touch with one another regardless of their physical location.

This year, the technical program committee has put together an exciting conference for you. Out of a total of 661 papers submitted, 363 papers are being orally presented and 104 papers for the poster sessions. The international participation of the VTC '97 is very evident from the fact that 73% of the papers were from countries other than the United States.

The technical papers have been arranged into eight parallel sessions, consisting of seven oral presentations and one poster session. In addition we have tutorials on Sunday, plenary sessions on Monday morning and panel sessions on Monday evening. A regulatory plenary is also planned for Tuesday morning.

The plenary session on Monday morning on "Mobile Satellite Communication Systems" will officially kick off the VTC Technical Program. The plenary session consists of four technical presentations from senior technologists representing the four major mobile satellite systems: Inmarsat-ICO-P, Iridium, Globalstar and Odyssey.

The tutorials on Sunday are designed to give the attendees an in-depth understanding of the technical subject. The evening panel session on Monday will give you an opportunity to hear the latest in "Wireless Communications" from industry experts. The Regulatory Plenary on Tuesday will highlight the latest developments in the regulatory field.

The Technical Program Committee members contributed significantly to bring you a top quality program for this conference. I extend my sincere thanks and appreciation to each member of the TPC. Special thanks goes to Vice Chairman, Dr. John Sadowsky, for assistance from the very beginning in various areas, Dr. Peter Okrah for putting together the tutorials and Dr. Bill Lee for arranging the panel session. Last but not least, I want to thank the authors, the invited speakers, and the panelists for enabling us to present you with an exciting conference.

On behalf of the technical program committee, I invite you to attend VTC '97 conference. In between technical sessions, several breaks are provided to facilitate peer-to-peer interaction and networking.

Welcome to the Valley and enjoy the conference!

Vijay Nair

Technical Program Committee Chairman

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CONFERENCE AT - A - GLANCE

MONDAY

8:00am - 11:30am Plenary Session - Mobile Satellite Communication Systems

12:15pm - 1:15pm Lunch

2:20pm-3:20pm
Session-MA1
Adaptive Antennas
for CDMA

2:20pm-3:20pm
Session-MB1
CDMA Interference
Rejection I

1:15pm-3:20pm
Session-MC1
Mobile Satellite
Propagation

1:15pm-3:20pm
Session-MD1
Propagation
Modeling I

1:15pm-3:20pm
Session-ME1
Wireless ATM I

1:15pm-3:20pm
Session-MF1
ITS

1:15pm-3:20pm
Session-MG1
Co-Channel
Interference
Cancellation

1:30pm - 3:30pm Poster Session MP1

3:35pm-5:35pm
Session-MA2
Adaptive Antennas
Arrays I

3:35pm-5:35pm
Session-MB2
CDMA Interference
Rejection II

3:35pm-5:35pm
Session-MC2
Mobile Satellite
Systems

3:35pm-5:35pm
Session-MD2
Urban Propagation
Models

3:35pm-5:35pm
Session-ME2
Wireless ATM II

3:35pm-5:35pm
Session-MF2
Handoff
Algorithms I

3:35pm-5:35pm
Session-MG2
Error Control Coding I

4:00pm - 6:00pm Poster Session MP2

7:00pm - 9:30pm Panel Session

TUESDAY

8:00am - 8:45am Regulatory Panel - Thomas Stanley

8:00am - 10:00am Poster Session TP1

8:50am-9:50am
Session-TA1
Antennas

8:50am-9:50am
Session-TB1
Multi-User Detection

8:00am-9:50am
Session-TD1
System Evolution

8:00am-9:50am
Session-TE1
Paging and Location Area
Engineering

8:50am-9:50am
Session-TF1
Handoff Algorithms II

8:50am-9:50am
Session-TG1
Blind Equalization

10:05am-11:05am
Session-TA2
DECT

10:05am-11:05am
Session-TB2
Multi-User Detection

10:05am-12:10pm
Session-TC2
Mobility Management

10:05am-12:10pm
Session-TD2
Adaptive Antenna
Arrays II

10:05am-12:10pm
Session-TE2
Wireless Channel
Performance

10:05am-12:10pm
Session-TF2
RF and Transmit/
Receiver Design

10:05am-12:10pm
Session-TG2
Equalization I

10:15am - 12:00noon Poster Session TP2

12:10pm - 1:25pm Awards Luncheon

2:30pm-3:45pm
Session-TA3
Multiple Access
Techniques

2:30pm-3:30pm
Session-TB3
Power Control

1:25pm-3:30pm
Session-TC3
Wireless Network
Optimization

1:25pm-3:30pm
Session-TD3
Ray Tracing Propagation
Models

1:25pm-3:30pm
Session-TE3
3rd Generation Wireless
System

1:25pm-3:30pm
Session-TF3
OFDM Techniques

1:25pm-3:30pm
Session-TG3
Equalization II

1:30pm - 3:15pm Poster Session TP3

3:30pm - 5:30pm Poster Session TP4

3:45pm-5:45pm
Session-TA4
ITS - Invited Session

3:45pm-5:45pm
Session-TB4
CDMA Power Control

3:45pm-5:45pm
Session-TC4
Wireless Traffic Modeling

3:45pm-5:45pm
Session-TD4
Radio Propagation Above
30 GHz

3:45pm-5:45pm
Session-TE4
Test Beds and Packet Data

3:45pm-5:45pm
Session-TF4
Synchronization I

3:45pm-5:45pm
Session-TG4
DSP Techniques

WEDNESDAY

8:00am-9:40am
Session-WA1
Wireless LANS

8:00am-10:00am
Session-WB1
Multimedia PRMA

8:00am-10:00am
Session-WC1
OFDM I

8:00am-10:00am
Session-WD1
Indoor Propagation

8:00am-10:00am
Session-WE1
Cellular Network Aspects

8:00am-10:00am
Session-WF1
Dynamic Channel
Assignment

8:00am-10:00am
Session-WG1
Diversity Techniques I

8:00am - 10:00am Poster Session WP1

10:15am-11:15am
Session-WA2
Multimedia Protocols

10:15am-11:15am
Session-WB2
ARQ

10:15am-12:20am
Session-WC2
CDMA Network
Performance

10:15am-12:20am
Session-WD2
Adaptive Antenna:
Measurements and Field
Trails

10:15am-12:20am
Session-WE2
Parameter Estimation for
CDMA

10:15am-12:20am
Session-WF2
OFDM II

10:15am-12:20am
Session-WG2
Channel Assignment in
PCS

10:15am - 12:00noon Poster Session WP2

12:20pm - 1:35pm Luncheon Keynote Speaker - Al Gross

1:30pm - 3:15pm Poster Session WP3

2:40pm-3:40pm
Session-WA3
GSM

2:40pm-3:40pm
Session-WB3
Transmitter/ Receiver
Techniques

1:35pm-3:40pm
Session-WC3
Synchronization II

1:35pm-3:40pm
Session-WD3
Antennas & Diversity

1:35pm-3:40pm
Session-WE3
Wireless Network
Architecture

1:35pm-3:40pm
Session-WF3
Multi-Carrier

1:35pm-3:40pm
Session-WG3
Interference Balancing

3:30pm - 5:30pm Poster Session WP4

3:55pm-5:55pm
Session-WA4
Frequency Hopping GSM

3:55pm-5:55pm
Session-WB4
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3:55pm-5:55pm
Session-WC4
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Propagation Applied to
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Design

3:55pm-5:55pm
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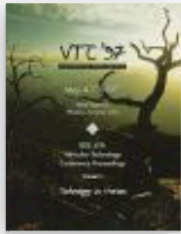
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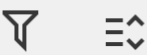
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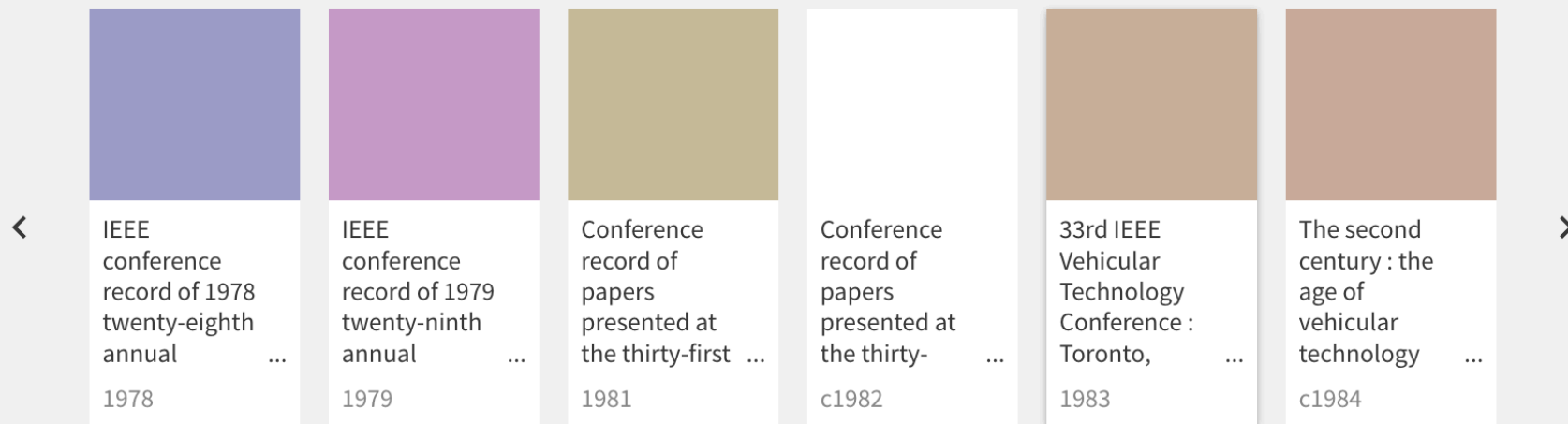
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Tufvesson, F., & Maseng, T., (1997, May), "Pilot assisted channel estimation for OFDM in mobile cellular systems," in the *1997 IEEE 47th Vehicular Technology Conference, Technology in Motion*, vol. 3, pp. 1639-1643.

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