



THE JOURNAL ON  
TECHNOLOGY AND  
PERSONS WITH  
DISABILITIES

## Real-time Synchronous Slideshow Presentation Access Technology for the Blind

Hyun W. Ka, PhD

Human Engineering Research Laboratories, Department of Veterans  
Affairs, Pittsburgh, PA

Department of Rehabilitation Science and Technology, University of  
Pittsburgh, Pittsburgh, PA

[hyk21@pitt.edu](mailto:hyk21@pitt.edu)

### Abstract

This research has developed a prototype software package called SPARC (Slideshow Presentation Access with Real-time Communication) that enables people with blindness or visual impairments to have synchronous access to slideshow presentation made with Microsoft Office PowerPoint, using cloud computing as a core Internet of Things (IoT) technology. The SPARC consists of three inter-related system components: a presenter add-in, a cloud service, and a user terminal application program. Once the slideshow starts, the presenter add-in automatically analyzes the current slide and convert it into accessible text format. Then, it publishes the converted text to the SPARC cloud service along with some metadata including a slide number, information on slide layout, and non-textual object properties in the current slide. The SPARC cloud service is a message-oriented middleware empowered by IoT technology and enables real-time communication between the presenter and the audience. The SPARC user terminal software is an application program that receives the slide information from the cloud service and displays it on user's assistive devices. In the lab trial where there were one computer on the presenter side and five different devices on the audience side, it was demonstrated that all the audience-side devices had successful real-time access to the current slide information synchronized with the active presentation on the presenter compute without any missing data and perceptible delays.

### Keywords

Information Accessibility, Presentation, Internet of Things, PowerPoint.

## Introduction

Since the year of 1987 when the first release of slide presentation software showed up in the world, the use of the presentation software, such as Microsoft PowerPoint and Apple's Keynote, has been a primary way to efficiently provide information to participants in many different settings including professional (work-related), education, entertainment, and general communication. Although there are no compelling results to prove or disprove that the use of slide presentation software is more effective for learner retention than traditional lectures (Savoy, Proctor and Salvendy), it is supposed to help both the presenters and the audiences. For the presenters, the use of presentation software can save a lot of time, who otherwise would have used other types of visual aid (e.g., hand-drawn, mechanically typeset slides, blackboards, whiteboards, and/or overhead projections). For the participants, its use can make their learning experience enriched by allowing them to have the information in more diverse formats (e.g., text, images, sound, movies, and other objects) with a variety of visual effects. Among presenters world-wide, the slideshow presentation software is used at an estimated frequency of 350 times per second (Parks).

However, people who are blind or visually impaired consistently find that it is impossible or difficult to have access to the information presented in forms of slideshow presentation. The total number of 7,327,800 adults (non-institutionalized, male or female, range of age 16 through 75+) with all education levels in the United States was reported to have a visual disability in 2013 (Erickson, Lee and von Schrader). According to the Annual Report 2014 published by American Printing House for the Blind, 60,393 legally blind children were enrolled in elementary and high school in the U.S, who are eligible to receive free reading matter in Braille, large print, or audio format (APH). Some presenters provide the alternative format of their presentation slides to the learners with vision issues in advance, so that they can read them through with their screen readers or Braille note-takers. However, it cannot meet their needs appropriately without providing real-time synchronous access to the information currently displayed on the public screen through their assistive reading technologies. In order to address this issue, this research has developed a prototype software package called SPARC (Slideshow Presentation Access with Real-time Communication) that enables people with blindness or visual impairments to have synchronous access to slideshow presentation made with Microsoft Office PowerPoint, which has at least 95% of the presentation software market share with installations on at least 1 billion computers (Parks), using cloud computing as a core Internet of Things (IoT) technology (Fig. 1).

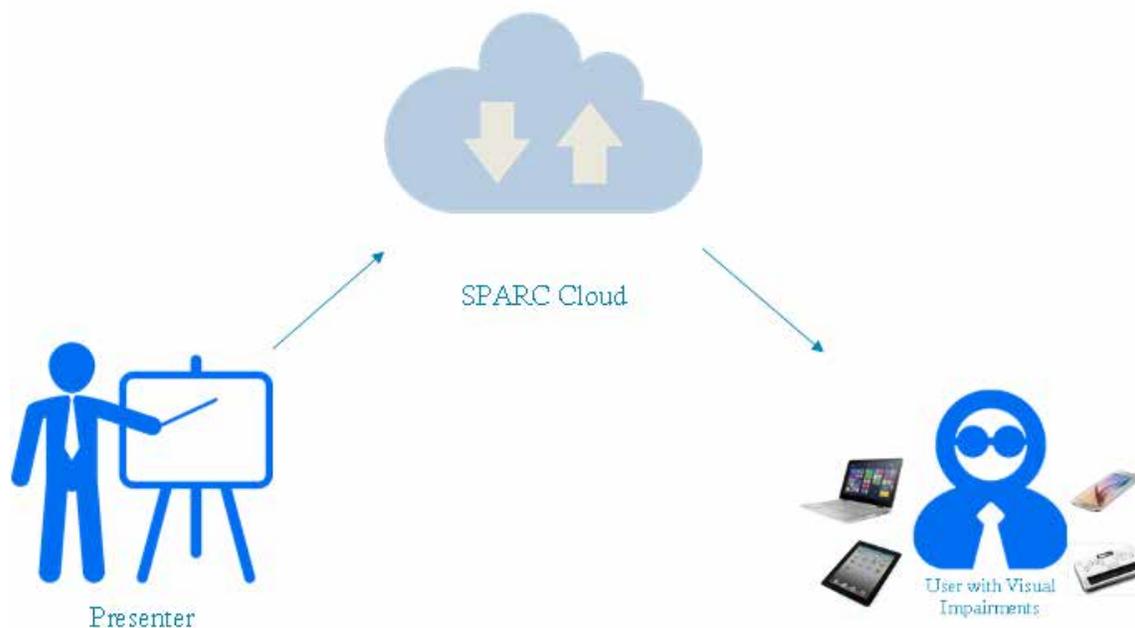


Fig. 1. SPARC Conceptual Diagram.

### **SPARC (Slideshow Presentation Access with Real-time Communication)**

The SPARC consists of three inter-related system components: a presenter add-in, a cloud service, and a user terminal application program. As shown in Fig. 2, the presenter add-in is a supplemental software program that provides custom accessibility features to Microsoft Office PowerPoint. It has been implemented with VSTO (Visual Studio Tools for Office) provided by Microsoft. VSTO provides 2 types of project templates: document-level customizations and VSTO Add-ins. Document-level customizations consist of an assembly that is associated with a single document. The assembly is loaded when the associated document is opened. Features in the customizations that the developer creates are available only when the associated document is open. VSTO Add-ins consist of an assembly that is associated with a Microsoft Office PowerPoint application. Features in VSTO Add-ins that developers create are available to the application itself, regardless of which documents are open. The VSTO Add-in not only runs automatically when the associated application is started, but users can also load VSTO Add-ins after the application is already running. The SPARC presenter add-in is based on a VSTO Add-In.

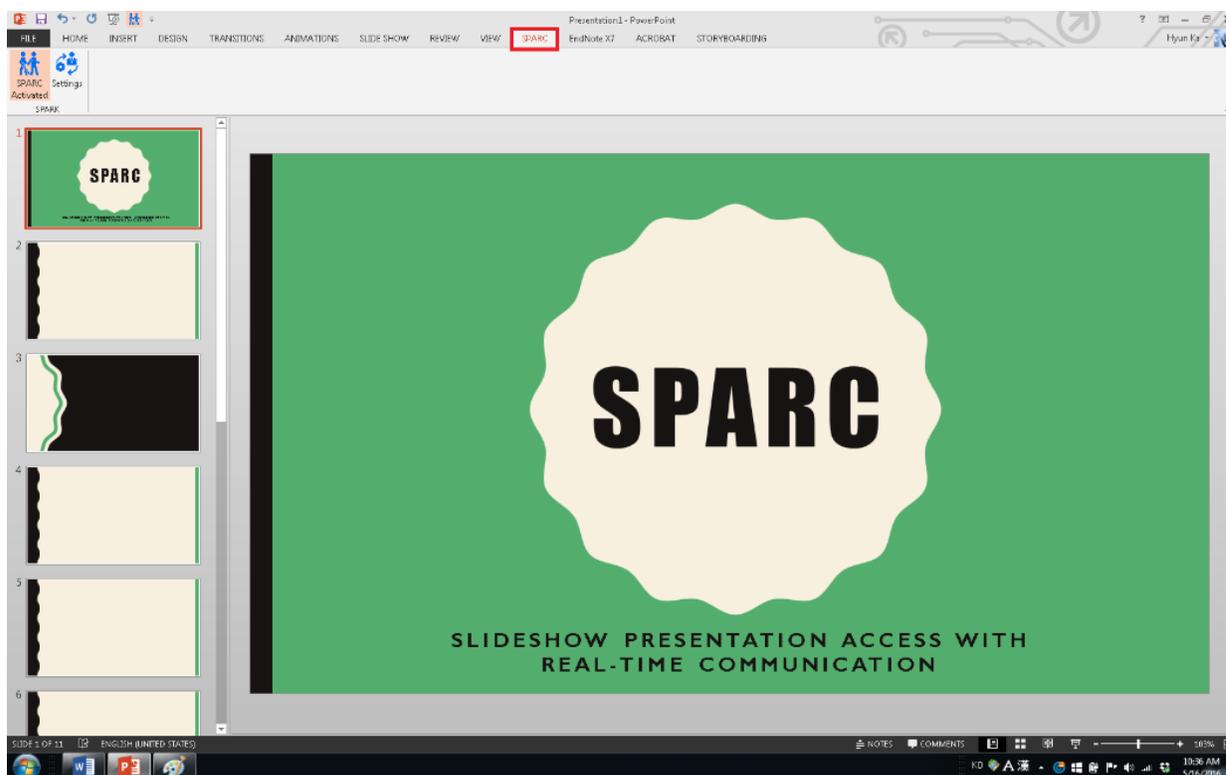


Fig. 2. SPARC Presenter Add-in.

When a presenter opens Microsoft PowerPoint program and activates the presenter add-in, a dialog box pops up and asks the presenter to name the current slideshow presentation, which should be shared with the audiences with visual impairments who are using the user terminal application. Once the slideshow starts, the presenter add-in automatically analyzes the current slide and convert it into accessible text format, based on PowerPoint Document Object Model provided by Essential Studio (Henry). The PowerPoint Document Object Model that represents the entire presentation with a hierarchical tree structure (Fig. 3). Each node in the tree corresponds to an element used in the PowerPoint presentation file, as shown in Table 1. Once Current slide information has been converted, the presenter add-in publishes the converted text to the SPARC cloud service along with some metadata including a slide number, information on slide layout, and non-textual object properties in the current slide. Whenever the presenter gives a new command to or navigates the active presentation, the SPARC add-in automatically recognizes the command/navigation event and publishes the updated information to the cloud service.

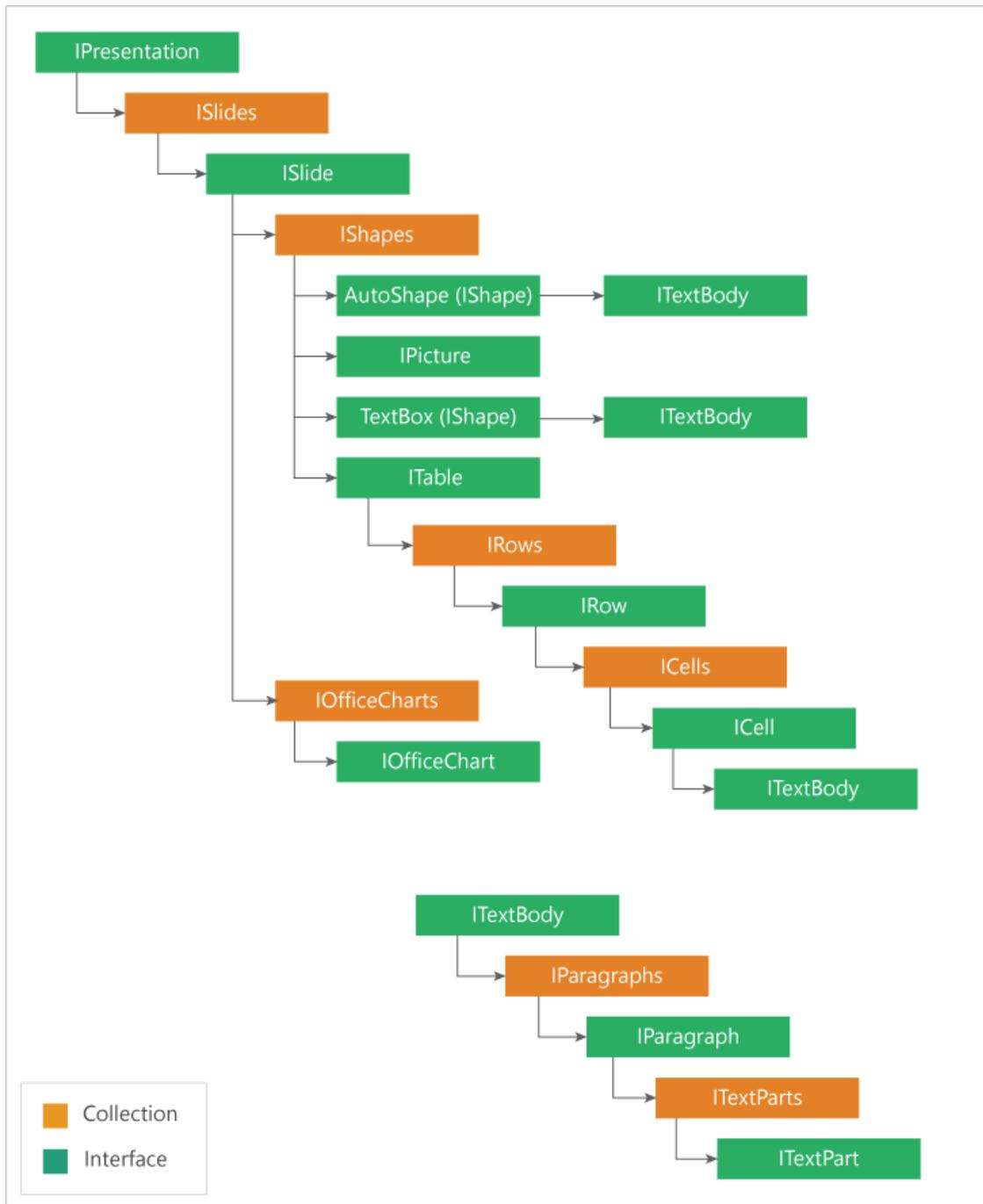


Fig. 3. PowerPoint Document Object Model.

**Table 1. PowerPoint Document Object Model**

<b>Element</b>	<b>Explanation</b>
<b>IPresentation</b>	It represents an entire PowerPoint presentation file. This presentation instance contains the slide collections present in the PowerPoint presentation file.
<b>ISlide</b>	It represents a single slide within a PowerPoint presentation, which in turn contains a collection of shapes. All the elements present within a slide are enclosed in a shape.
<b>IOfficeChart</b>	It represents a chart present within a slide.
<b>ITable</b>	It represents a table within a slide. A table instance contains a collection of rows.
<b>IRow</b>	It represents a single row in a table. Each row contains a collection of cells.
<b>ICell</b>	It represents a single cell within a row. A cell contains an instance of ITextBody.
<b>ITextBody</b>	It represents a container for textual content. It can contain a collection of paragraphs.
<b>IParagraph</b>	It represents a paragraph. Paragraphs can only be added into text boxes and auto-shapes. A paragraph contains a collection of text parts.
<b>ITextPart</b>	It is similar to <span> in HTML. An instance of ITextPart holds textual content of similar character-level formatting.
<b>IPicture</b>	It represents a picture or image in a slide.

The SPARC cloud service is a message-oriented middleware designed to empower Internet of Things and real-time communication between the presenter (publisher) and the audience (subscriber), using publish/subscribe model which allows any number of publishers to communicate with any number of subscribers anonymously in real-time (An et al.). The developed cloud service is implemented based on Google Cloud Pub/Sub Platform. The SPARC cloud service provides a rich set of API (application programming interface) supporting a standard representational state transfer

(REST) interface (Fielding and Taylor), WebSockets and MQTT, so that different types of platforms and devices can be connected and communicate seamlessly.

The SPARC user terminal software is an application program that receives the published slide information and displays it on user's devices. The current user terminal software was implemented based on a cross platform open source .NET framework called Mono (Mono). It is compatible with PC/Macintosh operating systems, iOS/Android smartphones and tablets, and network accessible Windows CE based Braille note-takers. When a user opens the SPARC user terminal application software, it asks to enter the slideshow presentation name shared by the presenter. Once the presentation name is given, the terminal software automatically subscribes to the active presentation via the SPARC cloud service and get and displays the current slide information in real time on the user's device.

## **Discussion**

In the lab trial where there were one computer on the presenter side and five different devices (Windows and Macintosh laptops, IOS and Android tablets, and a Braille note-taker produced by HIMS International) on the audience side, it was demonstrated that all the audience-side devices had successful real-time access to the current slide information synchronized with the active presentation on the presenter computer, which consisted of 11 slides with different slide layouts (Fig. 4), without any missing data and perceptible delays.

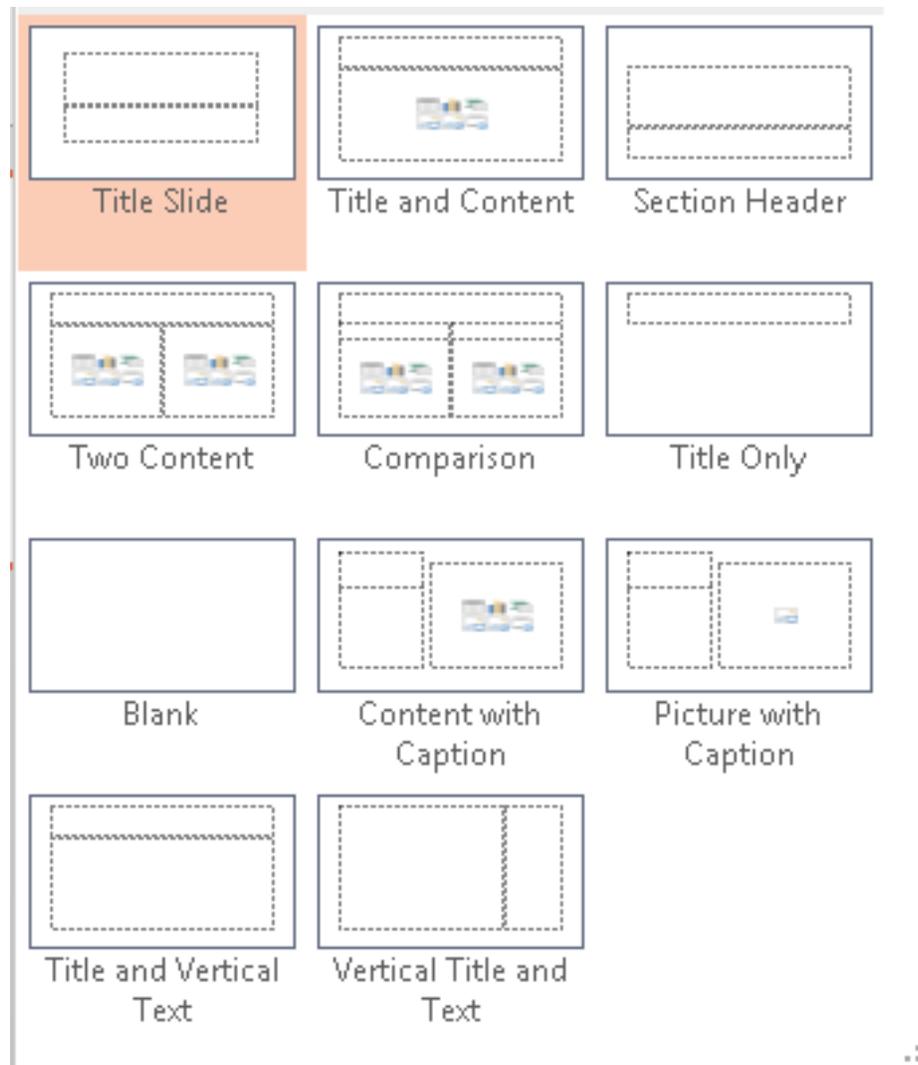


Fig. 4. 11 different slide layouts.

Although the SPARC demonstrated real-time synchronous access to the current slide information synchronized with the active presentation made with Microsoft Office PowerPoint, More refinement should be considered, because the evaluation conducted in this research were based on the 11 different slide layouts provided by Microsoft, which are recommended to use as templates for the screen reader users. Thus, for the slideshow presentation which does not use these standard templates, it is necessary for the SPARC to automatically detect the nonstandard slide, intelligently infer the missing information and convert it into accessible format. While testing with a wide range of custom slide formats, we are refining the software algorithm of the presenter add-in, applying a number of

machine learning algorithms. In addition, we are planning on holding multi-round focus groups with participants, who belong to end-user and key stakeholder population, to get their perceptions, opinions, and attitudes toward the refined SPARC and to guide future directions.

## Works Cited

- A Publish/Subscribe Middleware for Dependable and Real-Time Resource Monitoring in the Cloud.* Proceedings of the Workshop on Secure and Dependable Middleware for Cloud Monitoring and Management. 2012. ACM. Print.
- APH. "Annual Report 2014: Distribution of Eligible Students Based on the Federal Quota Census of January 7, 2013 (Fiscal Year 2014)." American Printing House for the Blind, 2014. Ed. Blind, American Printing House for the. Print.
- Erickson, W, C Lee, and S von Schrader. "Disability Statistics from the 2013 American Community Survey (Acs). Ithaca, Ny: Cornell University Employment and Disability Institute (Edi)." 2015. Print.
- Fielding, Roy T, and Richard N Taylor. "Principled Design of the Modern Web Architecture." *ACM Transactions on Internet Technology (TOIT)* 2.2 (2002): 115-50. Print.
- Henry, Usha Clementine. "New Library Creates and Manipulates Powerpoint Files." SyncFusion 2015. Web.
- Mono. "Cross Platform, Open Source .Net Framework." 2016. Web.
- Parks, Bob. "Death to Powerpoint!" Bloomberg Businessweek 2012. Web. September 5 2015.
- Savoy, A., R. W. Proctor, and G. Salvendy. "Information Retention from Powerpoint (Tm) and Traditional Lectures." *Computers & Education* 52.4 (2009): 858-67. Print.

## Journal on Technology and Persons with Disabilities

ISSN 2330-4216

LIBRARY OF CONGRESS \* U.S. ISSN CENTER  
ISSN Publisher Liaison Section  
Library of Congress  
101 Independence Avenue SE  
Washington, DC 20540-4284  
(202) 707-6452 (voice); (202) 707-6333 (fax)  
[issn@loc.gov](mailto:issn@loc.gov) (email); [www.loc.gov/issn](http://www.loc.gov/issn) (web page)

© 2016 The authors and California State University, Northridge

This work is licensed under the Creative Commons Attribution-NoDerivs 4.0 Unported License.

To view a copy of this license, visit <http://creativecommons.org/licenses/by-nd/4.0/>

All rights reserved.

