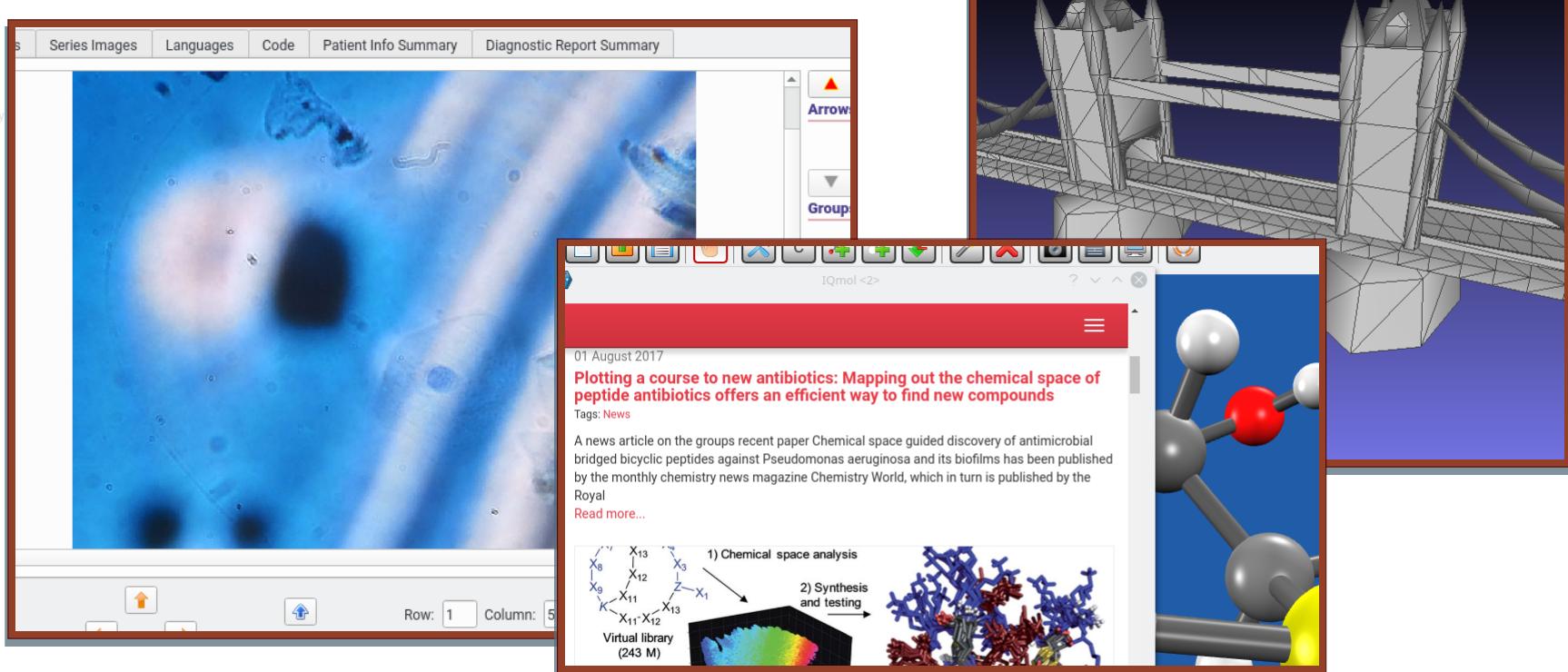


# The NCN/A3R ("NA3")

## Native Application Development Framework



Linguistic Technology Systems  
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# Team Members

**Lead Software Architect** Nathaniel Christen, Doctoral Candidate, University of Ottawa. Specializations: C++, Programming Language Implementation, Cognitive and Computational Linguistics, Scientific Computing, Philosophy of Science, Digital Humanities.

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**Medical Imaging and Data Communications Consultant** Alan H. Rowberg, M.D., formerly RIS/PACS Manager at Northwest Hospital; Co-Developer of DICOM protocol formerly Co-Chair of DICOM Standards Committee.

---

**Company Founder and CEO** Amy Neustein, Ph.D., Editor-in-Chief of the *International Journal of Speech Technology*; Editor of De Gruyter Series in Text Mining in Medicine and Health Care; Editor of SpringerBriefs in Speech Technology; Author/Editor of 12 academic books on subjects ranging from natural language processing, speech recognition, text mining, speech and automata, forensic speaker recognition, and mobile speech, to cyber-physical systems and smart.

# The NCN (Native Cloud/Native) Protocol

## Cloud/Native Components as back-ends for native software

- Our “Native Cloud/Native” protocol refers to native application front-ends paired with Cloud/Native (back-end) container instances.
- Code libraries and data representation may be shared across both endpoints.
- Common representation on both server- and client-side streamlines network communications (no need to marshal data between different formats).
- The NA3 technology can be ported to other application frameworks apart from Qt (wxWidgets, XCode, MFC, etc.).
  - Note: This presentation will focus on NA3’s default Qt implementation.

## How Cloud Back-Ends Enhance Native Front Ends

- Cloud Backup     ● Share Data between Users     ● Collaborative Editing
- Maintain users’ application state across different computers (home/school/office)
- Upgrade running applications without needing to re-compile

# “Application-As-A-Resource” (A3R)

## The A3R Application Model

- A3R Applications are self-contained, citable resources which can conform to modern resource documentation standards, such as the Research Object protocol.
- A3R Applications can use Hypergraph-structured metadata to describe data types, procedures, User Interface features, and inter-type relationships (for instance, the relation between data types and the types of GUI components which visualize them).

## A3R Developer Tools

- Hypergraph-based data modeling and serialization.
- Framework for building custom scripting, parsing, and data persistence engines.
- Enhanced support for applications specifically designed to access research data sets.
- Convenient framework for sharing data among applications (to establish inter-application workflows) or between applications and cloud or web services (including leveraging “NCN” services).

# The Qt Ecosystem and the Limitations of Qt in the Cloud

NA3  
Team  
NCN  
A3R  
Qt  
Business Strategy  
Qt  
Qt Comparability  
Software Development Market  
Potential NA3 Markets  
Examples

Qt is the most popular native, cross-platform application-development framework.

- ◆ ~1 million active developers ◆ Over 5,000 client companies ◆ Worldwide “Qt Partners” Ecosystem ◆ ~US \$25 billion overall market

## However ... Limited Qt Cloud Integration Support

- “Qt Cloud Services” Discontinued in 2016.
- Currently there is no standard model for accessing Cloud services from Qt applications.
- Nor is there a standard Qt-based Cloud/Native container architecture.

# NA3 Business Strategy

The NA3 Protocols encapsulate new technical models for Qt development and address recognized gaps in the Qt ecosystem, particularly the lack of a standard Qt Cloud Services. The strategy for promoting NA3 is therefore oriented to establishing NA3 within the Qt community, using the NA3's Qt implementation as a foundation to document NA3's essential hypergraph and type-theoretic concepts. On this basis NA3 can then be promoted in other application-development contexts.

## Within the Qt Market

- Promote NCN as a standard solution for Qt/Cloud Integration.
- Promote A3R tools for building custom scripting languages for Qt.
- Promote the A3R protocol as a standard model for inter-application networking, describing applications, and serializing application-specific data structures.
- On the basis of these enhancements to the Qt ecosystem, LTS hopes to join the Qt partners program, which would expose NA3's unique features to a worldwide developer community.

## Outside of Qt (see slide 9)

- Generalize the NA3 C++ reflection model and hypergraph libraries to standard (non-Qt) C++.
- Implement the A3R Protocols for standard C++ and for other languages (C#, Java, etc.).
- Implement language-agnostic hypergraph serialization to allow A3R networking between applications written for different operating systems and/or programming languages.

# NA3 Revenue Sources

## LTS projects NA3-related revenue from four sources:

- ◆ **Customization** Custom-implemented applications using project-specific versions of NCN and/or A3R.
- ◆ **Licensing** Commercial licenses required for any deployment of NCN outside LTS-controlled servers and/or any commercial deployment of A3R applications.
- ◆ **Hosting** LTS anticipates running proprietary containers via a Cloud-Native service such as OpenShift, and then leasing access to this service to NA3 users. LTS can offer integrated hosting and consulting wherein LTS fully implements and maintains a back-end paired to any desktop/native client software. Because the expertise involved in building native desktop applications is very different from the techniques required to deploy a Cloud-Native container image, the option of delegating all backend responsibilities to LTS may appeal to Qt-oriented development teams.
- ◆ **Sponsorship** LTS anticipates running a data-sharing platform which would be a publicly-visible introduction to NCN. This “demo” container would host research data sets and would therefore be a resource in the public interest, allowing LTS to receive compensation from companies financially supporting the portal given its merits as a technology benefiting science or scholarship.

# LTS Comparability in the Qt Market

Projections of LTS revenue can be grounded in the case-study of the Qt company and participants in the “Qt partners” program (see slide 5).

This slide considers sample Qt-based companies to establish a baseline for assessing the future growth of LTS.

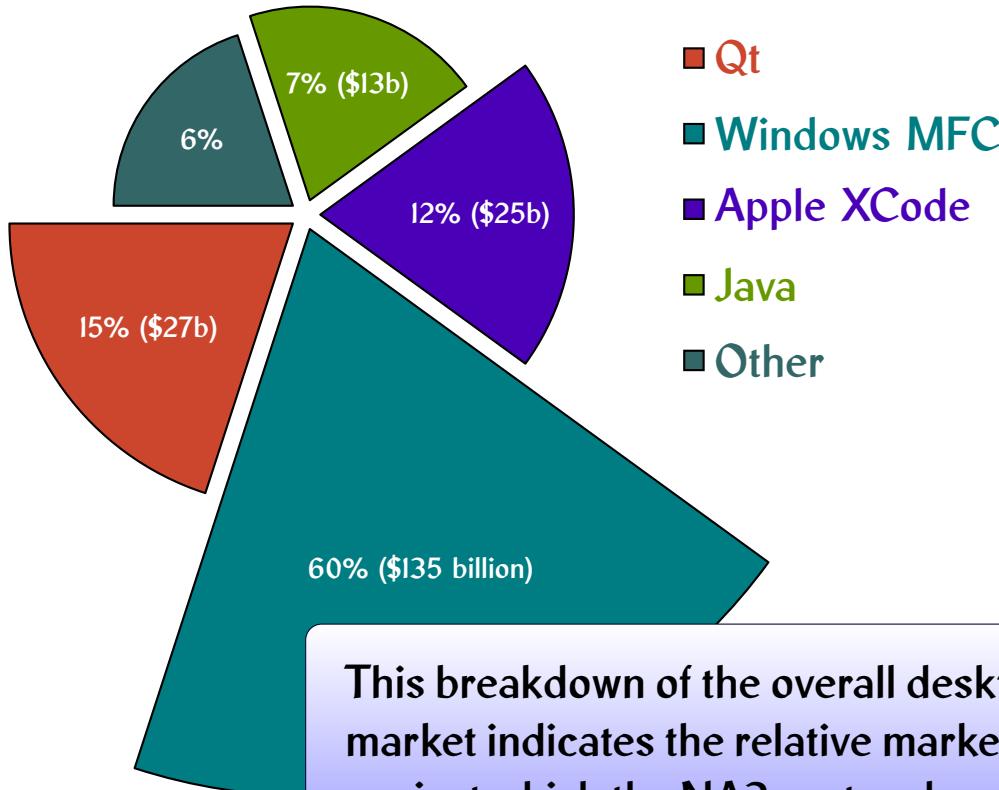
- ◆ **The Qt Group Plc** Financial records released by the Qt company suggest that commercial “Developer” and “Distribution” licenses are Qt’s largest revenues source (targets released in 2018 indicate that Qt aims for 60% revenue from licenses, 20% from consulting, and 20% for “support and maintenance”; total net revenue across these sources from 2018, the most recent figures available, was US \$57 Million at 2018 rates).
- ◆ **ICS (Integrated Computer Solutions)** *US \$25-50 Million annual revenue* (source: Glassdoor) ICS specializes in custom software development for companies in the military, aeronautics, and biomedical sectors. ICS exemplifies a Qt company whose revenue derives mostly from customization and consultation.
- ◆ **Toradex** *US \$16.2 Million annual revenue* (source: owler.com) Toradex specializes in microprocessors and embedded systems, one of the largest of several Qt partners focusing on embedded systems with Qt front-ends for touchscreens or desktop consoles monitoring cyber-physical networks.

# Overview of the Software Development Market

NA3  
Team  
NCN  
A3R  
Qt  
Business Strategy  
Qt  
Qt Comparability

Software Development Market

Potential NA3 Markets  
Examples



Taking the Qt implementations of the NCN and A3R protocols as a prototype, analogous versions may be built targeting other popular software-development platforms (see next slide for a more detailed outline).

# NA3 In Different Software Ecosystems

## Potential NA3 Markets

**Windows MFC** ( \$135b market size) A3R can be implemented in C++/CLI, building off of a generic-C++ version using the C++ Standard Library in place of Qt-specific data structures.

**Apple XCode** ( \$25b market size) Apple Operating Systems are based on Linux, so a Linux-oriented A3R implementation can form the basis of an XCode version. This XCode implementation would also be built around the C++ Standard Library.

**JavaFX** ( \$12.5b market size) The Java programming language provides the most widely used cross-platform application development framework outside of Qt. It is feasible to port C++ A3R implementations to Java. The core of this re-implementation would involve designing a Java Hypergraph Library compatible with the A3R serialization and Interface Definition protocol.

**Workflow Management** ( \$10b market size) A3R plugins can be added to new or existing applications to support inter-application networking, allowing multiple applications to be unified into workflow-management systems.

# Example Use-Cases

## Inter-Application Networking and Workflow Management

- Export data and instructions between Qt-based applications (slides 6-7).
- Embed document or multi-media viewers inside scientific or dataset applications (slides 18-21).

## Responsive desktop-style applications for enhanced UX

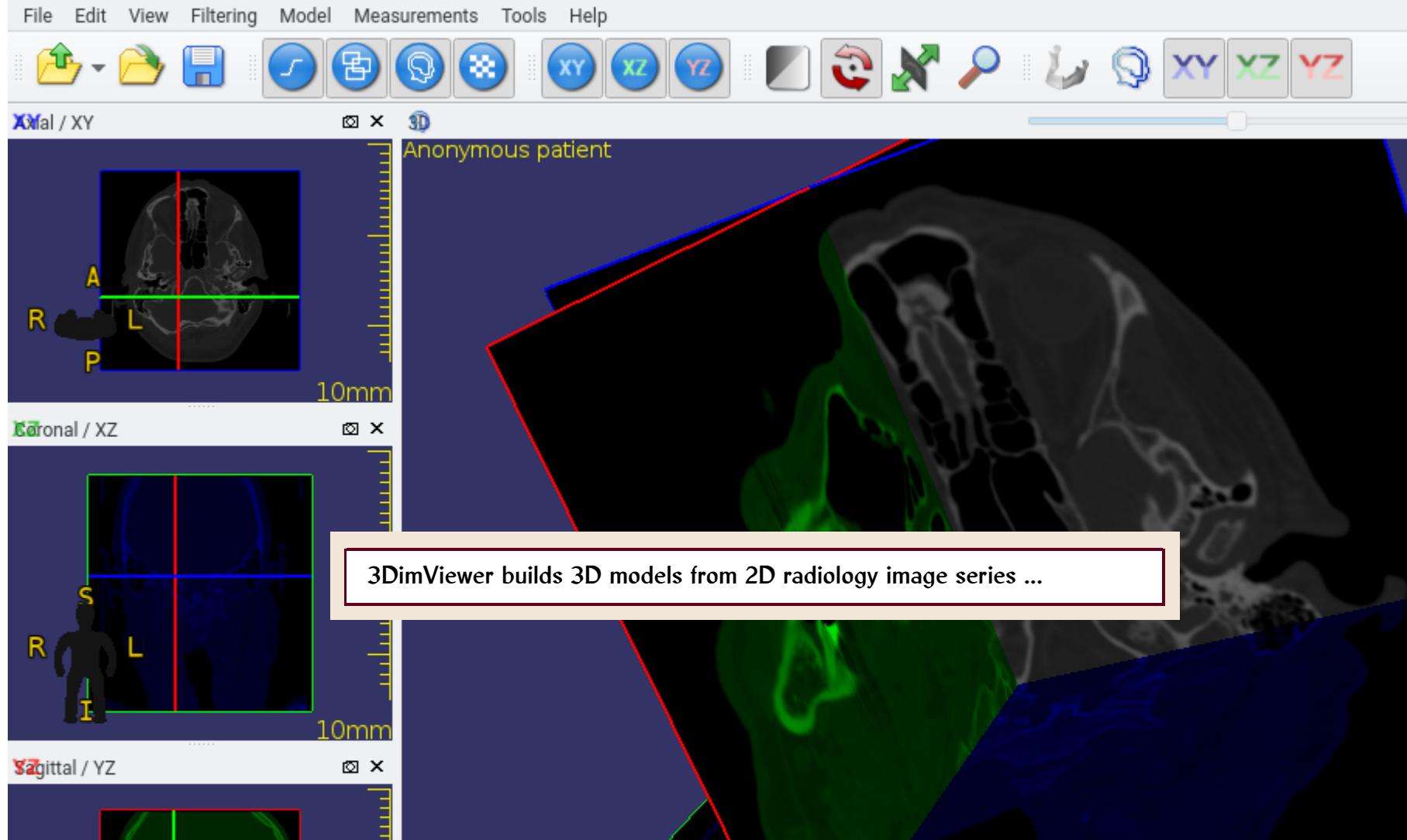
*Native applications offer superior User Experience, leveraging distinct interactive features of desktop GUIs: context menus, dialog boxes, tool tips, Multiple Window Display, dock windows, and so on:*

- Compelling front-ends for e-commerce (Note: “46% of global online retail orders happen on desktop”, source: leftronic.com), Real Estate, VR, etc. (slides 11-17).
- For scientists and researchers, build innovative data-collection instruments as well as interactive Research Object applications (slides 8-10).

# An Example of Inter-Application Networking

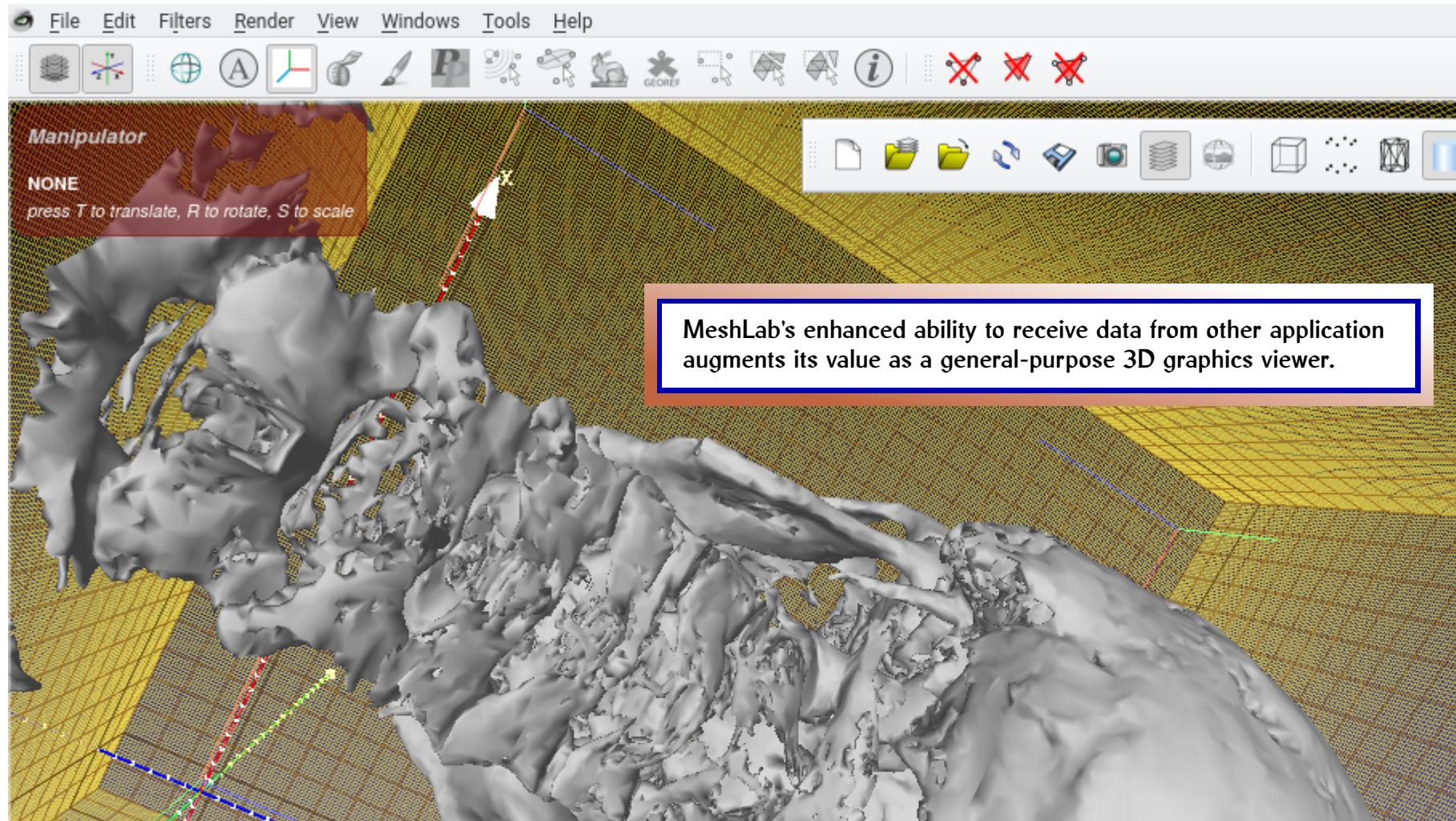
Research S  
Research Slide 2  
Research Slide 3  
Research Slide 4  
Research Slide 5

This slide and the next demonstrate a case-study where inter-application data sharing enhances the capabilities of two applications: 3DimViewer (a radiology tool) and MeshLab (a 3D graphics engine).



# 3D Graphics Sent to MeshLab

... Once the 3D tissue sample is constructed by 3DimViewer's algorithms, an A3R inter-application networking protocol (implemented as an extension to both applications) allows 3DimViewer to export the model to MeshLab so that it may be studied in a more comprehensive 3D viewing environment.



# A3R Applications as Data Collection Instruments

Research S  
Research Side 2  
Research S  
Research Side 4  
Research Side 5

Forms Web Language Help About

Save Form Open Form Cloud Save Cloud Open Submit Form

Page: 0 Search for: Forwards

Welcome Web

X ? ^ × Form Outline

Click on a subheading to continue

Patient Information  
Chief Complaint  
Review of Symptoms  
Treatment History  
Medical History  
Current Medications  
Family History

ndp-main-outline <5> ? ^ ×

Referring Doctor: Dr. New Test

Referred By (Choose One): Clinical Specialist

Date of Visit: 1/9/16

Please List your Previous Stays

1	Test 2	Sun	Mon	Tue	Wed	Thu	Fri	Sat
		31	1					
		7	8					6
		14	15					13
2	Test 1	21	22					20
		28	29					27
		4	5					3

OK Print

January 2018

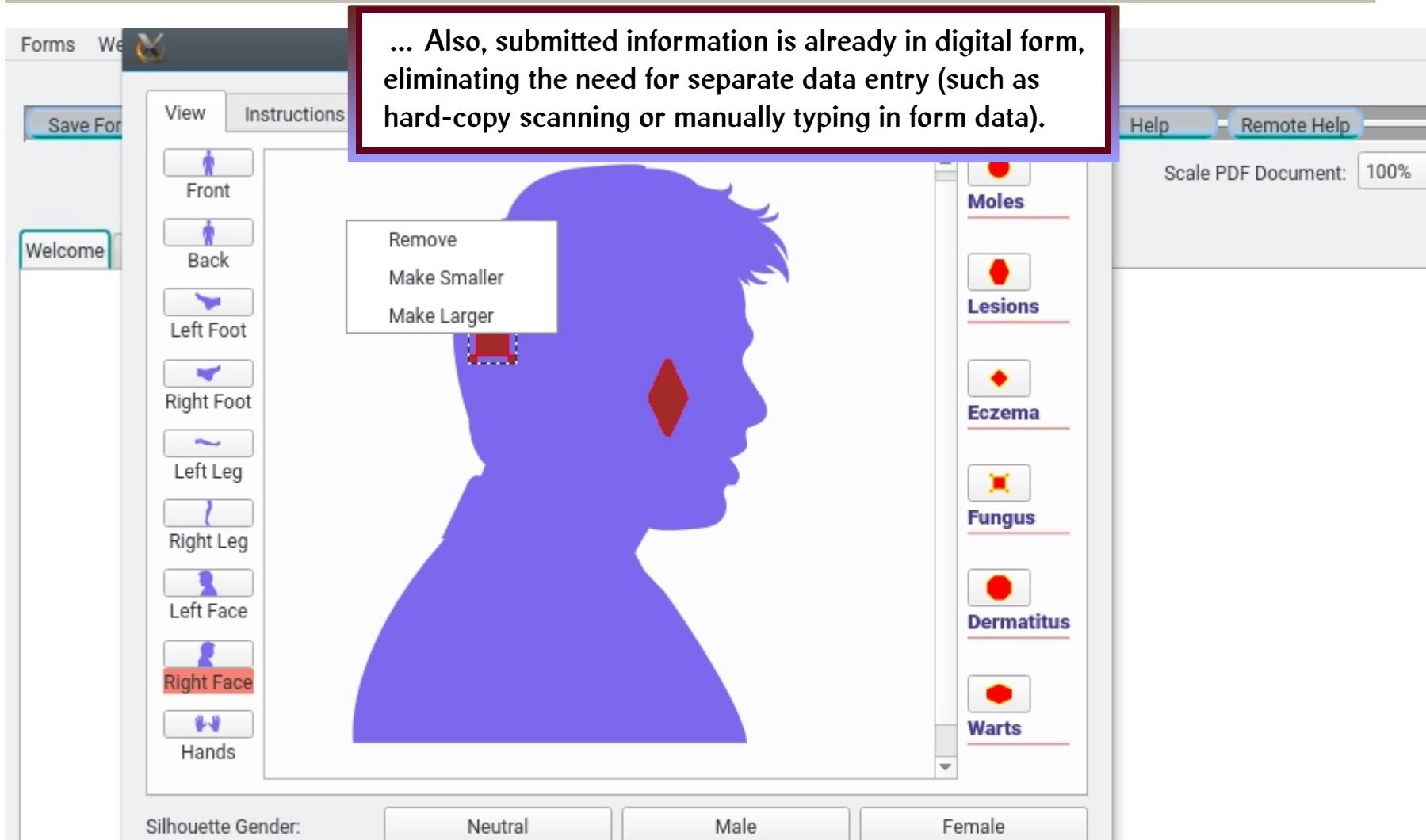
February 6  
March 13  
April 20  
May 27  
June 3  
July 10  
August  
September  
October

In medicine and social science, “data collection instruments” (DCIs) refer to surveys, questionnaires, and other tools to obtain human feedback.

# Qt-Based Interactive Forms

Research S  
Research Side 2  
Research Slide 3  
Research S  
Research Side 5

Data Collection Instruments implemented as native desktop applications can have easily navigable, interactive forms that make it simpler for people to provide information ...



# A3R Applications as Research Objects

Complementary to A3R components which facilitate *obtaining* research or experimental data, A3R “Data-Set Applications” are also powerful tools for visualizing and analyzing research findings.

Data-Set Applications are “Research Object Bundles” — combinations of code and data, providing access to data sets without the need for external software dependencies.

The interface shows a central image of a cell with a red arrow pointing to its nucleus. To the left is a vertical stack of small thumbnail images. To the right are toolbars for annotations: Arrows, Comments, Lists, Arcs, and Rulers. At the bottom are controls for Silhouette Zoom, Image Transforms, Annotations Transforms, and Pan/Zoom/Slide/Pan/Rotate/Zoom buttons.

Silhouette Zoom:



Clear

Image Transforms ...

Annotations Transforms ...

Pan

Zoom

Slide

Pan

Rotate

Zoom

# Native Applications as Interactive Catalogs

E-Commerce  
Slide 1

E-Commerce  
Slide 2

E-Commerce  
Slide 3

E-Commerce  
Slide 4

E-Commerce  
Slide 5

E-Commerce  
Slide 6

E-Commerce  
Slide 7

As a case-study in enhanced User Experience afforded by native applications, consider how static PDF catalogs and brochures can be turbo-charged into engaging, interactive software-based presentations.

The screenshot shows a native application interface for a product catalog. In the center is a large image of two brown leather sneakers with white soles. A context menu is open over the right shoe, listing options: Detach Image, Detach Noteboook, Detach Description, **Detach Everything** (which is highlighted), Merge Windows, Explore Color Matches ..., View 3D Model ..., Take Screenshot, View Item List, and View Shopping Cart. To the left of the main image is a sidebar with three smaller thumbnail images of different shoes. At the bottom left, there are navigation icons for up, down, and left-right. Below the image, the text "Item: 3" is followed by "Image Zoom:" and a zoom slider. At the very bottom, there are tabs for "Overview", "Features", "Specs", and "Reviews". Under the "Overview" tab, there is a bulleted list: • Leather upper, • Lace-up, • Round toe. On the right side, there is a section titled "Grand Crosscourt II Sneaker" with the text: "Sleek and simple, the Grand Crosscourt II sneaker from Cole Haan is the perfect way to add some tailored casual style to your every day look!". Below this, there is a section titled "Actions:" with two items: • [Add to Cart](#) and • [Explore Colors](#). There are also two small color swatches below the actions.

# Interactive Shopping Carts

Instead of static lists, shopping carts can be made into multi-dimensional, multiple-window interactive displays.

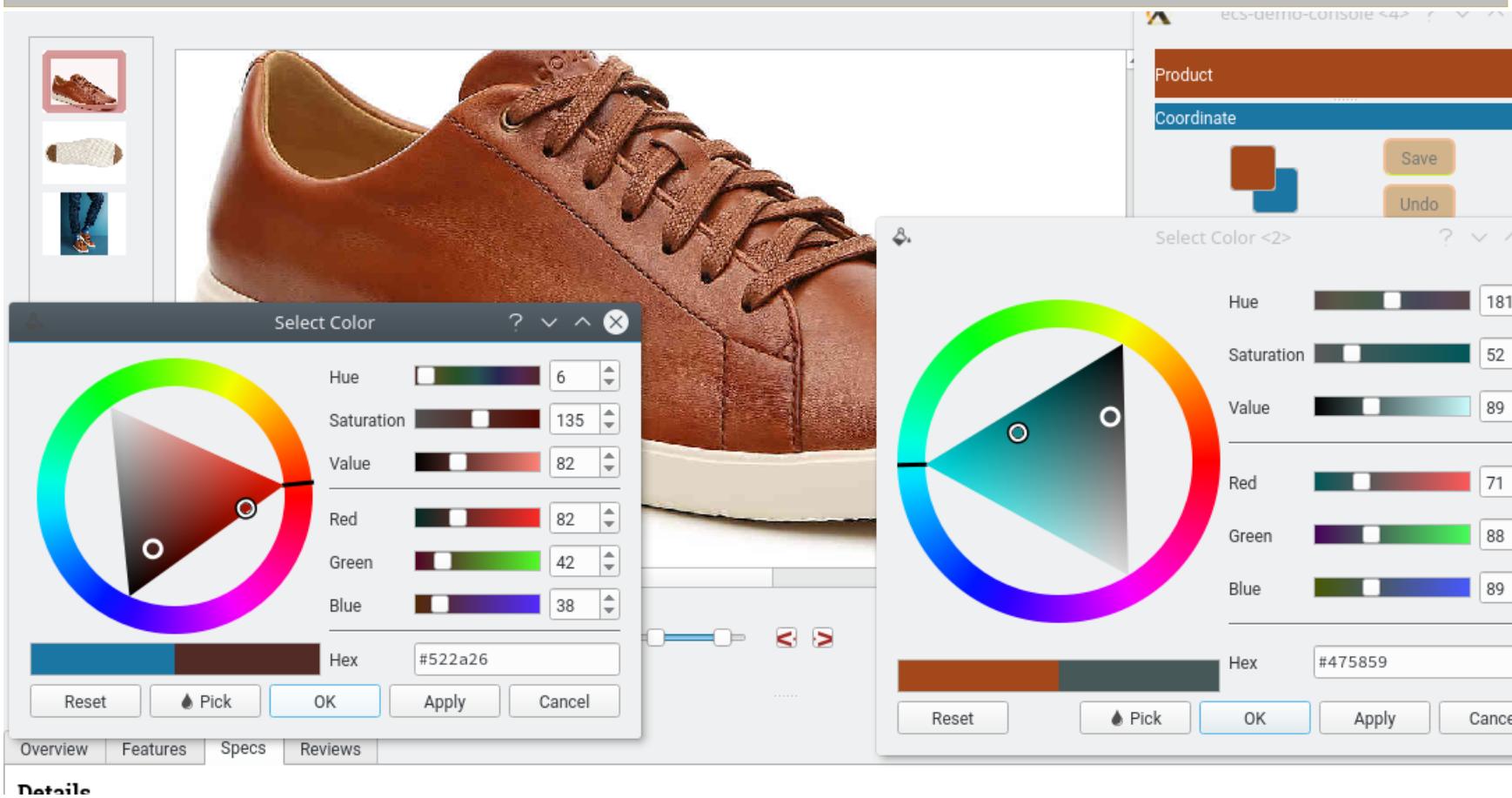
The screenshot illustrates a multi-dimensional shopping cart interface. At the top, a navigation bar includes File, Email, Events, APIs, Web, and Broadleaf. Below it are search and filter controls: Page: 0, Search for:, and a zoom setting at 100%. The main area features two overlapping windows, each titled "tecs-db-main <2>" and "tecs-db-main <3>".

- Window <2> (Left):** Displays a purple peony bouquet. The description on the left reads: "Lily Garden Silk Peony Bouquet Home Decoration, Lilac, 18 Inches High". The window has tabs for Overview, Specs, Reviews, and Q & A, with "Overview" selected. Buttons for OK and Cancel are at the bottom.
- Window <3> (Right):** Displays a large hydrangea arrangement. The description on the right reads: "Frosted Hydrangea, Mauve, 32 Inches High, 12 Floral Sprays". This window also has tabs for Overview, Specs, Reviews, and Q & A, with "Overview" selected. Buttons for OK and Cancel are at the bottom.

# Explore Products with Native Software

E-Commerce  
Slide 1  
  
E-Commerce  
Slide 2  
  
E-Commerce  
Slide 3  
  
E-Commerce  
Slide 4  
  
E-Commerce  
Slide 5  
  
E-Commerce  
Slide 6  
  
E-Commerce  
Slide 7

Interactive catalogs allow designers to incorporate many unique features and capabilities of desktop applications, such as using HSV color-wheel controls to explore color coordination while shopping.



# Interactive Real Estate

E-Commerce  
Slide 1  
E-Commerce  
Slide 2  
E-Commerce  
Slide 3  
E-Commerce  
Slide 4  
E-Commerce  
Slide 5  
E-Commerce  
Slide 6  
E-Commerce  
Slide 7

A3R programming can also bring enhanced UX to Real Estate presentations: instead of just groups of photos, properties can be displayed via interactive, multi-dimensionally organized, color-coded photo viewers.

The screenshot shows a software interface for viewing real estate photos. On the left, a grid of thumbnail images represents different property types. A specific thumbnail in the bottom row is highlighted with a red border and has an arrow pointing to a larger, detailed view of a bedroom on the right. The bedroom has green walls, a large wooden bed, and a chaise lounge. A white callout box with a dark border contains the text "Current Photo". On the far left, a vertical panel titled "Groupings" lists categories with corresponding colored bars: Entrance/Foyer/Hall (teal), Kitchen/Dining Room (yellow-green), Living Room/Den (purple), Bath/Powder Room (blue-gray), Bedroom/Closet (teal), Master Bedroom/Spa (light green), and Basement/Game Room (gray). The word "Groupings" is also present above the list. At the bottom of the interface, there are navigation arrows, the text "Item: 19", an "Image Zoom" slider, and "OK" and "Cancel" buttons.

Groupings

- Entrance/Foyer/Hall
- Kitchen/Dining Room
- Living Room/Den
- Bath/Powder Room
- Bedroom/Closet
- Master Bedroom/Spa
- Basement/Game Room

Current Photo

Color-Coded Groups

Item: 19

Image Zoom:

OK Cancel

# Photo Viewer Interactive Cues

E-Commerce  
Slide 1  
  
E-Commerce  
Slide 2  
  
E-Commerce  
Slide 3  
  
E-Commerce  
Slide 4  
  
E-Commerce  
Slide 5  
  
E-Commerce  
Slide 6  
  
E-Commerce  
Slide 7

These slides demonstrate visual cues aiding photo navigation, such as color bands (overlays) that switch from horizontal to vertical indicating which photos have been viewed so far; and the thumbnail of the current viewed photo marked with a thick colored border (surrounding the thumbnail photo and its overlays).

The screenshot shows a photo viewer interface with a grid of thumbnails on the left and a large preview image on the right.

- Already Viewed (vertical color band):** A callout points to a thumbnail in the second row, third column, which has a thick vertical purple border.
- Not Yet Viewed (horizontal color band):** A callout points to a thumbnail in the fourth row, fifth column, which has a thin horizontal purple border.
- Current Photo (viewed for the second time):** A callout points to a thumbnail in the second row, first column, which has a thick horizontal purple border.

**Groupings:**

- Entrance/Foyer/Hall
- Kitchen/Dining Room
- Living Room/Den
- Bath/Powder Room
- Bedroom/Closet
- Master Bedroom/Spa
- Basement/Game Room

Item: 10

Image Zoom:

# Filtering Photos

Another feature which may be conveniently implemented in A3R-style photo viewers is a filtering option, which — given a collection of pictures classified into several groups — allows users to show or hide photos based on the group they belong to (note the check-box buttons on the group listing).

The screenshot shows a photo viewer interface with a sidebar of thumbnail images and a main view showing a living room. The sidebar includes a 'Groupings' section with a list of room categories and their corresponding check boxes.

**Visible Groups:** Entrance/Foyer/Hall (checked), Living Room/Den (checked), Bedroom/Closet (checked), Master Bedroom/Spa (checked).

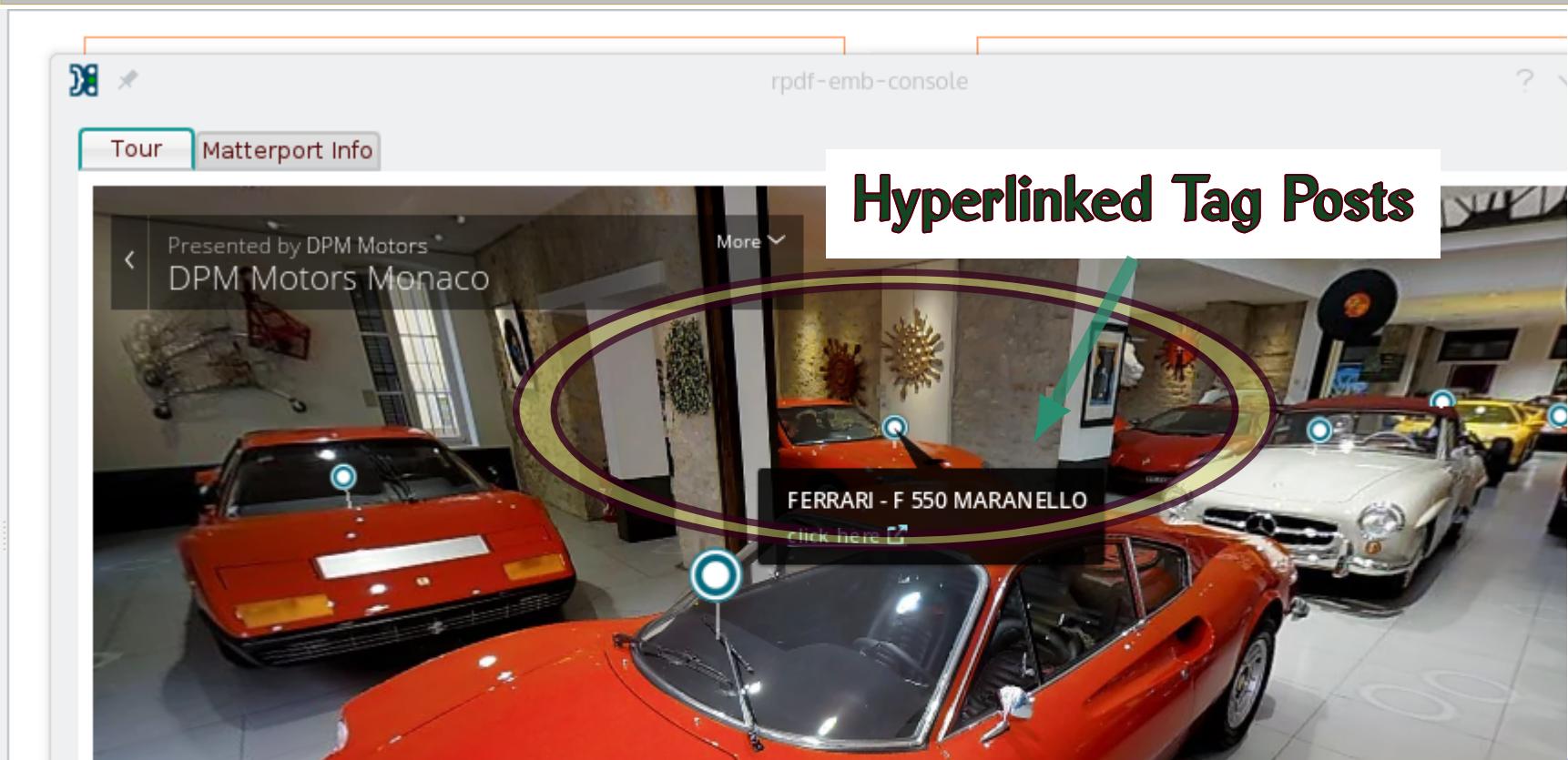
**Check Boxes:** Kitchen/Dining Room (unchecked), Bath/Powder Room (unchecked), Basement/Game Room (unchecked).

**Hidden Groups:** The 'Hidden Groups' section is partially visible at the bottom of the sidebar.

Below the sidebar, there are navigation arrows, an 'Item: 3' indicator, an 'Image Zoom:' slider, and 'OK' and 'Cancel' buttons.

# Interactive VR: Hyperlinked Tag Posts

Another emerging technology, relevant to both e-Commerce and Real Estate, is the use of Panoramic Photography to create immersive Virtual Reality scenes. Panorama-Photography-based VR engines, like Matterport, allow “tag posts” with embedded hyperlinks, which in a native-application context become channels of communication between the VR renderer and the host application. The full capabilities of this interactive modality — combining VR with clickable links and text “bubbles” — can only be fully realized via Virtual Reality engines (such as WebGL) embedded in native software.



# A3R Document Viewers

Publishing  
1  
Publishing Slide  
2  
Publishing Slide  
3  
Publishing Slide  
4

A3R applications may embed viewers for document formats such as e-Pub, HTML, and PDF; then supplement conventional publications with special components customized for individual manuscripts: e.g. (as in this case), a widget allowing readers to visually explore patterns in classical Indian music.

The screenshot shows a digital journal interface. At the top, there are three icons: a gear, a book, and a person reading a book. Below the icons are tabs for 'References', 'Library', and 'Reading'. A horizontal menu bar includes 'HTML Source', 'Lisp', 'CSS', and 'XML'. A large red rectangular area covers the main content area. Below this, the text 'Read article view' is visible. At the bottom, there is a navigation bar with a left arrow, a central search or filter icon, and a right arrow.

## ANTHROPOLOGY AND HUMANISM

[Explore this journal >](#)

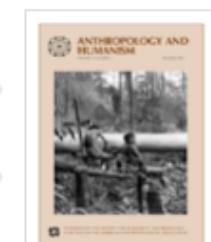
Ethnographer as Apprentice: Embodying  
omusical Knowledge in South India

da Weidman

Published: 26 December 2012 [Full publication history](#)

The screenshot shows a specialized A3R viewer window. At the top, it says 'Display Tala Types: Jhoomra/Dhamar (14 beats)'. Below this is a large rectangular area containing two horizontal grid patterns. The top pattern has 14 red squares in a single row. The bottom pattern has 14 squares arranged in two rows of 7. To the right of the patterns are scroll bars and a vertical separator bar. Below the patterns, the word 'Patterns' is followed by a slider with 'Pattern 1 (3-4-3-4)' on the left and 'Pattern 2 (' on the right. Further down, there is a 'File' field containing the path '/extension/ScignSeer/articles/svg/tala.svg' and a 'Proceed' button.

Volume 37, Issue 2  
December 2012  
Pages 214-235



# A3R Document Viewers as Embedded Components

Publishing 1  
Publishing 2  
Publishing Slide 3  
Publishing Slide 4

Document Viewers may also be embedded in host applications which provide domain-specific visualization capabilities. For example, chemistry papers might be viewed within IQmol (a Qt-based program for molecular visualization and physical/chemical analysis) via an A3R document-viewer plugin.

The screenshot shows a chemistry application interface. At the top is a menu bar with options: Display, Build, Calculation, SONIC, and Help. Below the menu is a toolbar with various icons. On the left, there's a sidebar with a "Springer" logo and some search results. A context menu is open over a 3D molecular model, showing options like "Configure", "Select All", "Reperceive Bonds", "Duplicate Geometry", "Atomic Charges", and "Remove". An "SONIC" option is also present in the menu. A small window titled "SONIC Reader" is overlaid on the interface, containing links to "Springer Keyword Search: Cysteine", "Springer Web Search Home", and "Search Saved Articles". The main area features a large 3D ball-and-stick model of a molecule, with atoms represented by spheres of different colors (blue, yellow, red, white).

Showing 157 results.

Book

**Cysteine Proteases of Pathogenic Organisms**

Robinson, M. W. (Ed), Dalton, J. P. (Ed) (2011)  
Cysteine proteases expressed by pathogenic organisms play key roles in virulence including host

[www.springer.com/gp/search?query=cysteine&submit=Submit](http://www.springer.com/gp/search?query=cysteine&submit=Submit)

# Document Viewers Augmented With APIs

Publishing  
1  
Publishing Slide  
2  
Publishing  
3  
Publishing Slide  
4

Another strategy for interactive publications is linking documents with APIs maintained by publishers, or by cultural or educational institutions.

View Instructions

As an example, documents mentioning artifacts held in a museum can provide features to view more information about those museum-pieces through the host institution's API.



**MEDAL**

 Click the icon to save

This is a **Medal**. We acquired it in 1920. It is a part of the **Product Development** department.

Cite this object as

Medal; bronze; 1920-3

Row: 0 Column: 0

# Embedded Multimedia

Publishing  
1  
Publishing Slide  
2  
Publishing Slide  
3  
Publishing  
4

Custom-built A3R document viewers can provide convenient access to multimedia content embedded in or linked to texts — including audio files, videos, and 3D graphics scenes or models.

*Ailurus fulgens styani* (also known as *a. f. fulgens*): Only found in China (in the Hengduan

Mo  
My  
The  
ab

In this case a video player is launched in a dialog box, floating above the article text. For those reading digital books or articles, videos and other multimedia content can be presented through secondary windows launched via context menus; text and multimedia may thereby be viewed side-by-side.

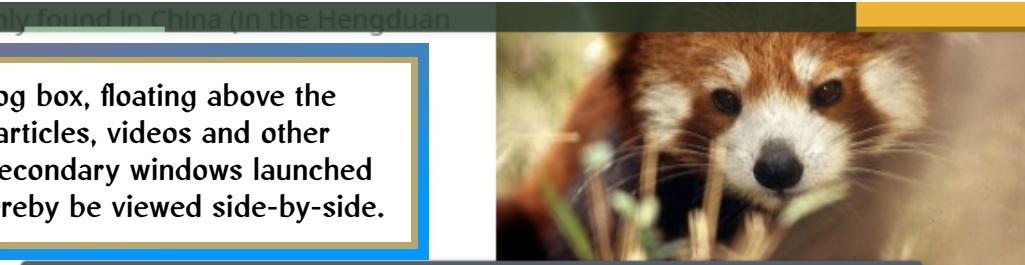
## Behavior

Red pandas are generally solitary, but there are a couple of cases where they develop extended associations with their mothers that last throughout the breeding season.



In terms of territoriality, red pandas tend to have overlapping home ranges with other. This means that they do not search for their own food, but instead patchily distributed across the landscape.

[arkive.org/red\\_panda/about-the-red-panda/](http://arkive.org/red_panda/about-the-red-panda/)



ScignSeer Video Player

ARKIVE  
www.arkive.org

Moving images copyright  
© BBC Natural History Unit

Sound recordings copyright  
© BBC Natural History Unit  
© Natural FX

Restart Pause Play

URL file:///ext\_root/videos/a.mp4

OK Proceed Cancel

# Thank You!

Thanks

Please contact Linguistic Technology Systems for more information about NA3 and/or other Software Development and Software Language Engineering Solutions: (917) 817-2184.

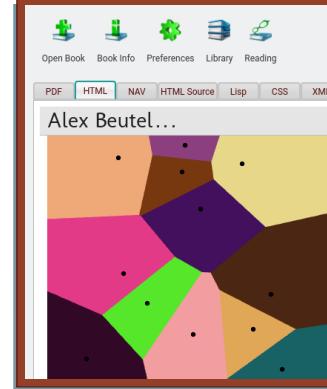
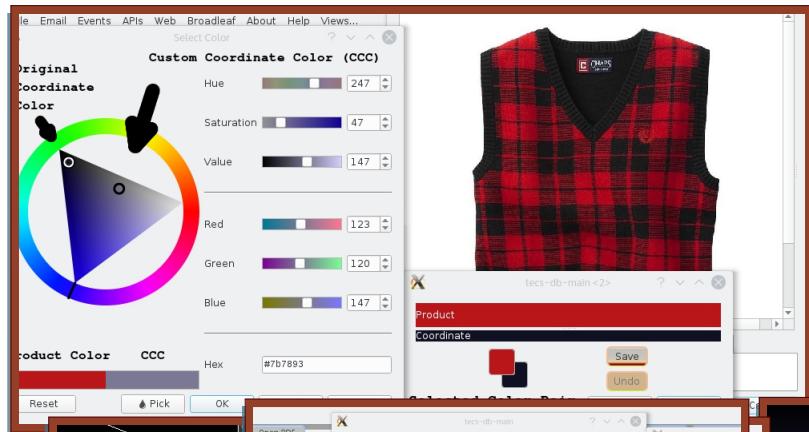


Figure 2 The Voronoi Diagram of the set of Melbourne's inner city train stations

It should also be noted that this account aims to represent space partitioning at a cognitive rather than at a physical level. What this means is that *at* will not be

