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Interactive Vector Annotation Layers and Distributed Payload Buffer Serialization for Cloud-Native Document Review Interfaces

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ABSTRACT: Clinical reviewers who work through faxed prescriptions need a way to mark what is missing on the page and to pass those marks to cloud services in a structured form. This paper proposes a framework for cloud-based document review interfaces that combines interactive vector annotation layers with distributed buffer-based payload loading, with faxed prescription processing as the target application. Healthcare technicians and clinical reviewers highlight and label missing dose details, diagnosis information and administration instructions directly on the prescription image. A client-side vector marking engine built on HTML5 Canvas and WebGL draws in document coordinates, so the scanned image itself is never modified. Annotation records are held in a buffer whose schema can be extended during review and are serialized to JSON in memory for exchange between the browser and distributed cloud services. Rendering and buffer management are designed to limit memory consumption, prevent leaks and keep the interface responsive when many documents are handled. The intended result is easier prescription clarification and less ambiguity in the documentation passed between reviewers. The framework has not yet been evaluated empirically.

KEYWORDS: Cloud-Native Document Review, Vector Annotation Layers, Healthcare Document Processing, HTML5 Canvas, Coordinate Mapping, JSON Payload Serialization, Memory Management.

I. INTRODUCTION

Many healthcare organizations still receive prescriptions as faxed or scanned images, and much of the handling in their document management systems (DMS) is still manual, from scanning and transcription of handwritten prescriptions to review of diagnosis reports and other clinical documents. The prescriptions themselves are often incomplete. Dose details are missing, instructions on how to take the medication are ambiguous, diagnosis information is written incorrectly, or the timing is unclear. Each gap means another exchange among pharmacists, healthcare technicians, clinical reviewers and prescribers, and can interrupt the medication process and continuity of care. Document interfaces that support interactive annotation and structured information exchange are one way to shorten that loop.

Annotation tools for biomedical text have been studied extensively. Dobbie et al. [1] built Markup, a web-based annotation tool that uses active learning to bring the human reviewer into the identification of information. Neves and Ševa [2] compared tools for manual document annotation on functionality, usability, accessibility and support for collaborative work. Their review shows that annotation styles vary widely, so an interface has to accommodate different document types and different kinds of annotation.

Clinical information extraction raises a separate question of reliability. Canales et al. [3] developed a methodology for evaluating clinical NLP systems, arguing that automation tools used in clinical documentation need systematic assessment. Tutubalina et al. [4] applied neural models to a Russian drug reaction corpus to detect drug reactions and treatment effectiveness in user reviews. Both studies treat medication information as structured data that can be extracted and checked. A prescription review interface needs the same property when it flags dosage, diagnosis or administration fields for confirmation.

Review is also collaborative. TeamTat [5], a collaborative text annotation tool, shows that annotators can share both the annotation history and the current set of annotators for a text. Prescription review adds requirements that text tools do not face. Marks must stay aligned with what is visible on the scanned sheet, and the original image quality must be preserved. A reviewer should be able to point to the incomplete part of a prescription, such as missing medication details or an unclear administration time, and report it without altering the image. The annotation layer therefore has to be non-destructive and tied to the image through a well-defined coordinate mapping.

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On the technical side, a cloud review interface has to render the document, capture and structure annotations, and exchange them between the front-end GUI and distributed back-end document services. HTML5 Canvas and WebGL suit this kind of vector interaction, letting reviewers highlight, draw and mark regions on a scanned prescription. Marks must stay accurate as the document is zoomed, scrolled and re-rendered, which requires a coordinate transformation between screen and image and a consistent image overlay. When many documents are processed, annotation objects and their data structures also have to be managed carefully. Larger annotation workloads may need an annotation buffer whose schema can expand, and an optimized in-memory JSON serialization step for transfer between the browser and the cloud service. Browser memory has to be kept under control throughout, so that redundant objects do not accumulate and the browser stays responsive.

Prior work covers annotation, clinical information extraction and collaborative curation, but not their combination in a prescription review tool that works on images. Such a tool must also handle non-destructive image overlays, coordinate maintenance, growing annotation buffers, JSON serialization and browser memory, which the text-oriented systems above largely leave aside.

This paper presents a framework, Interactive Vector Annotation Layers and Distributed Payload Buffer Serialization, for cloud-native document review interfaces. Its client side consists of a vector markup engine, an overlay with exact coordinate mapping, an annotation buffer whose schema can be extended at run time, and non-destructive JSON payload serialization. In the target healthcare use, a technician or clinical reviewer locates and flags missing details, such as Rx dosage, diagnosis or medication administration, on the scanned image of a faxed prescription. The design goals are precise annotation, simpler prescription clarification, document rendering that scales with volume, and uninterrupted data flow to cloud services.

II. RELATED WORK

Work relevant to this paper falls into web annotation applications, manual document annotation, biomedical entity retrieval, clinical text processing and collaborative annotation workspaces. Few of these studies deal with image-based annotation, flexible annotation data structures, coordinate management and payload serialization together in a cloud-based healthcare application.

Markup [1] is a web-based text annotation tool supported by active learning. Running in the browser helps accessibility and fits annotation into an existing workflow, and the tool is a reasonable model for interfaces that let users add information to a document through annotation. Scanned prescription images, however, need accurate vector coordinates and annotation payloads that can grow during review, which require architectural work beyond a text annotation tool.

Neves and Ševa [2] compared the features and properties of existing manual annotation environments. Their criteria include structured information support, document visualization, annotation consistency and usability. Manual annotation remains necessary where a person must interpret context that automated systems cannot. Prescription review is such a case: the reviewer may be looking at a partly completed dosage instruction, an illegible detail or a faxed prescription that lacks clinical information. The annotation types surveyed in [2] are useful design guidance, but image-based, graphical annotation tied to document organization receives little attention there.

Canales et al. [3] proposed a methodology for evaluating clinical NLP systems, focusing on systematic evaluation and on the reliability of information extraction in clinical settings. A review system has a related obligation, since the link between a document and the information it contains must be preserved, for instance when a missing or unclear part of a prescription is marked. Interactive graphical annotation adds a need that NLP evaluation does not cover, namely representing newly created information, persisting it and tying it to a visual location.

Tutubalina et al. [4] examined the Russian Drug Reaction Corpus and neural models for detecting drug reactions and effectiveness information in user reviews. The work concerns structuring biomedical information and recognizing drug-related concepts in text, and such methods could be applied to medication data to identify potential medication problems. Finding out what a medication is for and marking a gap on a scanned prescription are different tasks, though they complement each other. A review platform should therefore let the user mark the relevant portion of the document directly and interpret the clinical information there.

TeamTat [5], introduced in Section 1, shows that annotation history and the set of annotators can be shared in a distributed setting. Distributed prescription review needs the same kind of sharing.

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Several systems automate or assist concept annotation. PubTator Central [6] annotates biomedical concepts such as diseases and drug actions in full-text articles and links them to related information, which supports retrieval and curation. SemEHR [7] is a semantic search system that extracts and displays information from clinical notes so that it can be used in healthcare applications. ezTag [8] uses interactive learning to help users tag biomedical concepts.

Textpresso Central [9] combines biomedical literature search, personalized text mining, visualization and curation in one platform. MERLOT [10], built by Campillos et al., is a French clinical corpus annotated for clinical entities and the relationships among them. Both depend on consistent representation of domain-specific information and structure, which is also what allows annotations to be managed reliably.

Jovanović and Bagheri [11] surveyed how biomedical knowledge is represented, with a focus on semantic annotation. Several tools address collaborative work. GATE Teamware [12] is a web-based framework for collaborative text annotation, Egas [13] is a collaborative and interactive document curation platform, MyMiner [14] is a web application for computer-assisted biocuration and text annotation, and BioCause [15] supports annotation and analysis of causality in biomedical text. These systems are built around text. Graphical marks on scanned images, the setting of this paper, need the additional mechanisms described in Section 3.

III. CLOUD-NATIVE VECTOR ANNOTATION AND ADAPTIVE PAYLOAD ORCHESTRATION FRAMEWORK

The framework supports interactive annotation and structured data management in cloud-based healthcare document review. It is aimed at prescriptions that are illegible, handwritten, ambiguous, or partly or wholly incomplete, for example missing dosage, diagnosis or administration instructions. Reviewers mark up the displayed image graphically, and the original document image is not edited. One processing architecture covers annotation-buffer management, coordinate transformation, serializable vector annotations, JSON payload serialization and memory-efficient rendering. Figure 1 shows how document rendering, vector annotation, adaptive payload management and cloud-based synchronization fit together.

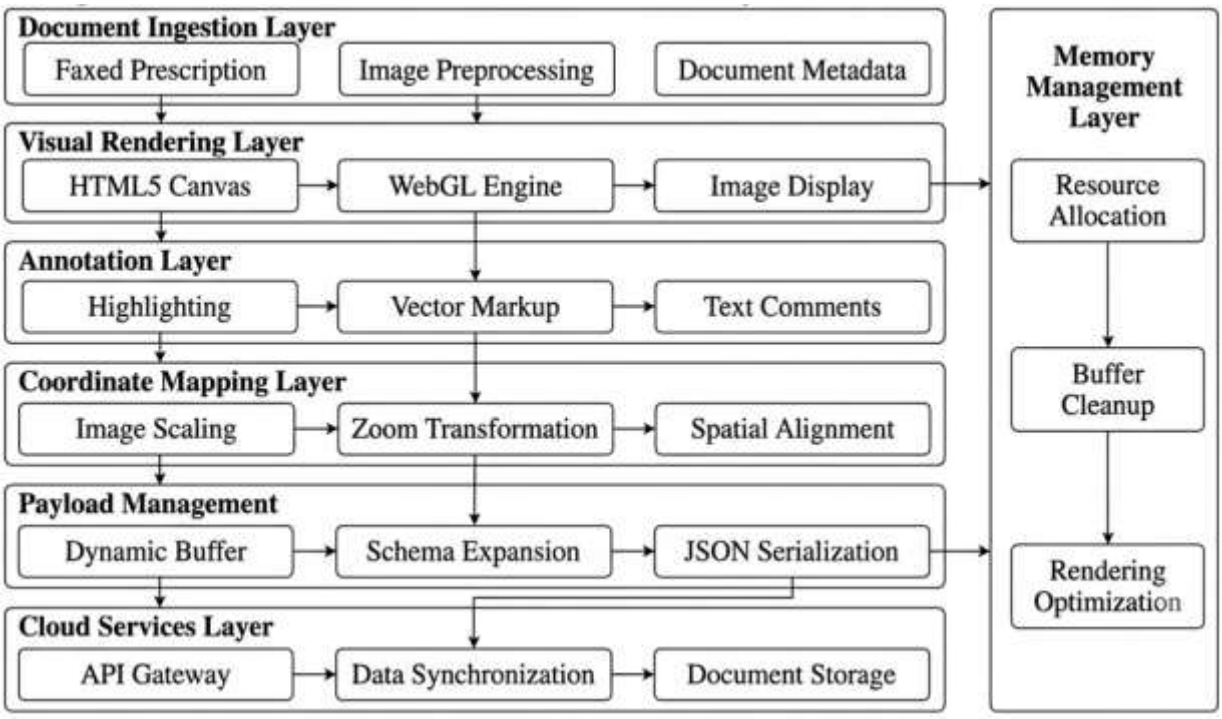

Figure 1. Integrated Cloud-Native Vector Annotation and Payload Orchestration Framework

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3.1 Document Ingestion and Rendering Layer

Scanned prescription images first enter the framework through a document ingestion layer, which prepares them for viewing in the browser. Healthcare documents can arrive in a variety of image formats, resolutions, sizes and orientations, so the ingestion process produces a uniform representation for later display and annotation. Document metadata such as image size, file-level identification and rendering properties preserves the link between the original image and its interactive version.

The prescription image is displayed in a web browser. HTML5 Canvas suits both document display and interactive drawing, and WebGL can take over heavier work such as accelerated graphics operations. The source image and its graphical annotations are drawn independently, so annotation never modifies the source. Because the annotations form their own layer, reviewers can move or remove them, or discard a whole round of review, without touching the document.

3.2 Non-Destructive Vector Annotation Layer

The vector annotation layer is the main channel through which reviewers communicate. It supports graphical objects such as rectangles, lines, arrows, freehand drawings and text over selected areas of the prescription image. Reviewers can use it to flag areas needing clarification, including missing dosage, absent medication information and missing diagnosis entries.

Annotations are not part of the image. They are stored out of band as a separate set of vector graphics. An annotation object can hold an identifier, graphical type, position, dimensions, visual properties and associated text or a reference to a related document. This representation allows annotations to be extended during review. For example, a dosage region may first be marked with a rectangle, and text may then be attached saying that the frequency shown in the rectangle must be confirmed.

Keeping the image layer apart from the vector layers makes non-destructive document management possible. The original prescription stays visible, and an annotation layer adds a second representation, the reviewer's interpretation. Annotations can be added or removed, and annotated parts of the image can be retrieved in a structured way, without repeatedly changing the source image.

3.3 Adaptive Coordinate Mapping and Spatial Synchronization

The basic requirement for annotating scanned documents is that annotations land in the right place. A prescription image can be scaled to fit the browser window, zoomed in for detail and scrolled within the window. The coordinates of an annotation object drawn on the screen image may therefore differ from the coordinates of the corresponding location in the original image.

The coordinate mapping component keeps the vector information consistent with the displayed image. When it converts user interaction coordinates into document-relative coordinates, it takes viewport displacement, display scaling, zoom level and image size into account. A reference coordinate system based on the original image size is maintained, so that annotations stay in the correct position even when the document is resized or shown at different zoom levels.

The component also synchronizes the image-rendering surface with the annotation layer. Both layers share the same transform settings, so graphical objects move together with the document region they mark. Accurate mapping matters most when reviewers examine fine details in a prescription, such as dosages or administration instructions: a mispositioned annotation could leave reviewers unsure what it refers to.

3.4 Dynamic Annotation Buffer and Schema Expansion

The adaptive annotation-buffer component handles the structured information produced by user interaction. A fixed annotation structure may become limiting when reviewers add new annotation types or extra data attached to individual graphic objects. The framework therefore lets the data representation expand dynamically as needs grow.

Additional properties can be added depending on the annotation type or review activity. A text annotation, for instance, may need only the text to be annotated, while a rectangular annotation may need a location or a size value. This flexible representation lets graphical objects carry different property sets without forcing every object to share the same one.

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The buffer management mechanism handles insertion, update and deletion of annotation records during a review session and keeps each annotation grouped with the prescription document it belongs to. Changes accumulate in the in-memory structure until serialization, so annotations can be revised step by step and the buffer accommodates different review approaches. Figure 2 shows how interactive annotation objects are transformed into structured JSON payloads through adaptive buffer management and distributed cloud communication.

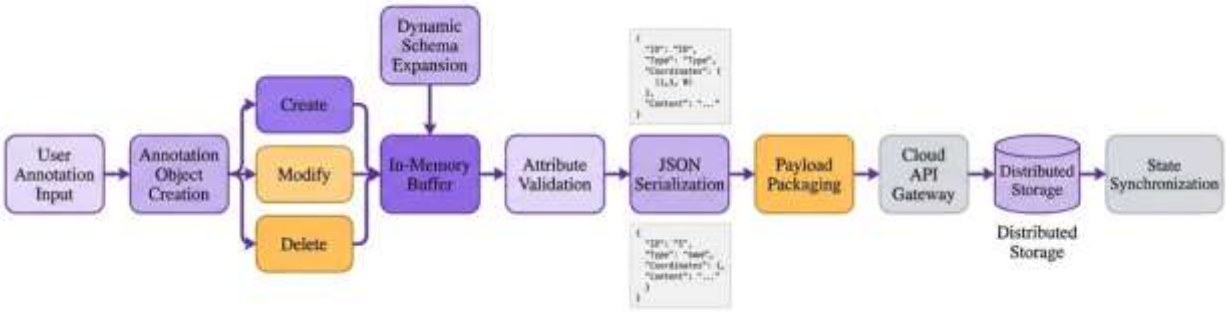

Figure 2. Dynamic Annotation Buffer and Distributed JSON Serialization Workflow

3.5 Distributed JSON Payload Serialization and State Management

The serialization component translates the in-memory representation of an annotation into a structured JSON payload that can be stored, sent or processed in a cloud-native application. A payload can contain document identification information, annotation identifiers, vector properties, coordinate information, annotation text and other relevant information. Because annotation content is kept separate from the original image, annotation updates do not duplicate the document.

The framework structures annotation data into identifiable records, so that individual changes can be managed without treating the whole document as one graphical record. Depending on the application architecture, the serialized data may be sent to a server-side document management service or held temporarily in the client application. The serialized form keeps each annotation's link to its document and its relations to other annotations, so the annotated view can be recreated later.

State management correlates user actions with annotation objects and the in-memory buffer with the serialized payload. An annotation's state changes when a reviewer creates or modifies it, before it is ready to be persisted. This keeps the image and the structured data sent by the application consistent.

3.6 Memory-Aware Rendering and Resource Lifecycle Management

A document review session may involve several prescription images, zoom changes and many added notes. If resources are not managed properly, unneeded render objects, event listeners and temporary data structures can remain in browser memory. For this reason the framework includes a memory-aware rendering and resource lifecycle module.

This module creates rendering resources in response to actions on a document, then recycles and disposes of them. Temporary graphical objects and leftover annotation references are removed once they are no longer needed. Event listeners for document interactions follow the lifecycle of the interface components that own them. Rendering can be limited to the portion of the document actually visible, skipping the rest where appropriate.

The framework also separates persistent annotations from transient visual resources. An annotation object and its representation objects can be serialized and recreated, and the serialized copy should yield an equivalent object when needed. The split is meant to keep long review sessions from accumulating rendering objects.

3.7 Integrated Review and Cloud Synchronization Workflow

The workflow module ties these components together. Once the prescription image has been acquired, vector drawings such as lines and text are drawn over it, and parts of the document outside the reviewer's current view are displayed as needed. Spatial information belongs to the coordinate mapping component and annotation data to the adaptive buffer. The serialization component writes changes into a structured JSON payload, and the resource management component

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handles temporary rendering resources. Figure 3 outlines the prescription clarification workflow and shows how interactive annotations link clinical review activity with prescriber communication and updated documentation.

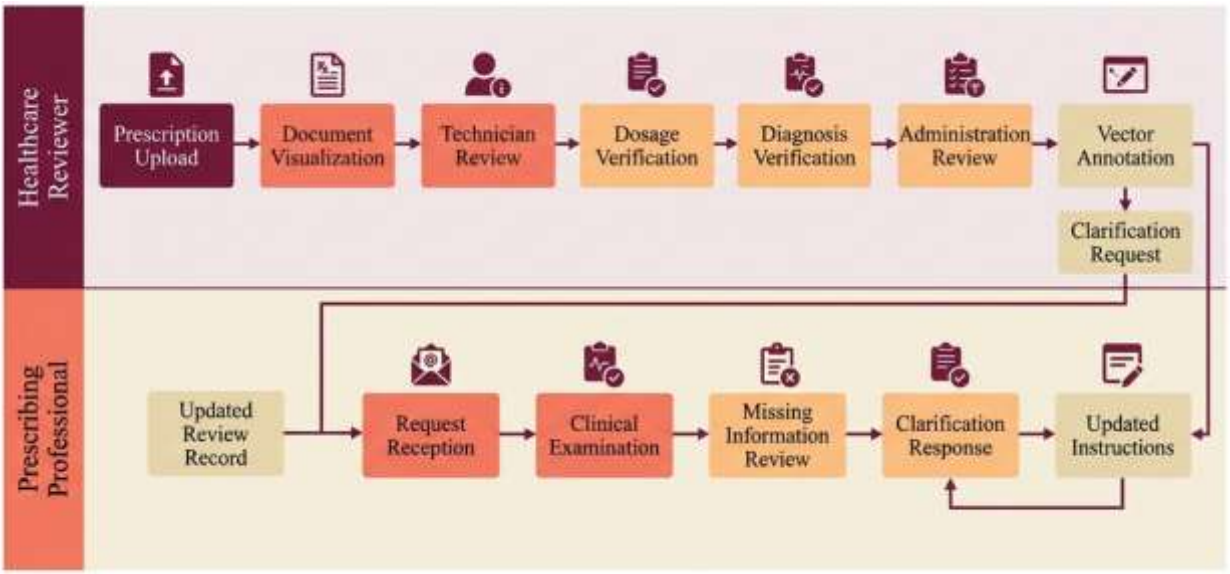

Figure 3. Healthcare Prescription Review and Clarification Workflow

In practice, a reviewer can mark up a prescription as freely as the case requires while the original record stays unchanged, and rendering cost and memory use are kept down. Graphical annotation and its semantics are modeled separately but kept synchronized, which keeps prescription records consistent and intact as the number of reviewed documents grows.

IV. EMPIRICAL ASSESSMENT OF ANNOTATION INTEGRITY AND ADAPTIVE PAYLOAD ORCHESTRATION

4.1 Annotation Accuracy and Visual Consistency

Assessing whether graphical annotations stay correctly tied to prescription areas calls for empirical evaluation, which this paper does not report. At the design level, the non-destructive vector overlays let reviewers point out missing dosage information, incomplete diagnosis entries and unresolved medication-use decisions without changing the original record. Coordinate mapping keeps annotations consistent when images are resized, zoomed and repositioned. Both properties matter in clinical document review, for annotation and for traceability.

4.2 Adaptive Payload Structure and Serialization Reliability

The mechanism can represent different annotation types and their associated attributes. With dynamic schema expansion, a fixed schema is not required for every graphical object, so an annotation can be changed without changing the schema. JSON serialization makes the structure easy to describe and to exchange between the browser and distributed cloud services. Separating document images from annotation metadata can reduce data duplication and lets annotations be updated independently.

4.3 Rendering Efficiency and Memory Management

The framework takes a memory-conscious approach to rendering, which helps when many documents are handled. When a graphics object is discarded, the persistent annotation remains, so the lifecycle of graphics objects can be controlled. Selective rendering, clearing stale references and managing event listeners within the workflow avoid unnecessary memory growth in the browser. These mechanisms are intended to keep the interface responsive over long review sessions.

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4.4 Healthcare Workflow Applicability and Overall Assessment

From a healthcare perspective, the framework provides an orderly way to discover and communicate ambiguities in prescriptions. Marking the unclear text directly on the image lets reviewers specify exactly what is unclear, which reduces uncertainty in communication with other reviewers.

On these criteria the architecture appears conceptually and functionally adequate with respect to annotation integrity, payload adaptability, serialization and rendering resource management. The assessment is qualitative. It suggests the design could support applications that combine document understanding with structured cloud data capture while leaving the original clinical document intact.

V. CONCLUSION

This paper presented a framework for annotating scanned prescriptions in cloud-native document review interfaces. Vector marks are drawn in a separate layer, mapped to image coordinates, held in an extensible buffer and serialized to JSON, so that reviewers can flag missing dosage data, missing diagnosis data or vague administration instructions without modifying the scanned image. The framework also addresses coordinate consistency, flexible annotation structures, information exchange and browser resource use when many documents are handled. Its benefits for review consistency, efficiency and scalability have not been measured and still need to be confirmed by empirical evaluation. Future work includes intelligent addition of annotations, automatic completion of prescription fields, integration with EHR systems and synchronization for distributed review, with the aim of supporting prescription clarification, information traceability and secure collaboration among healthcare technicians, pharmacists and prescribers.

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