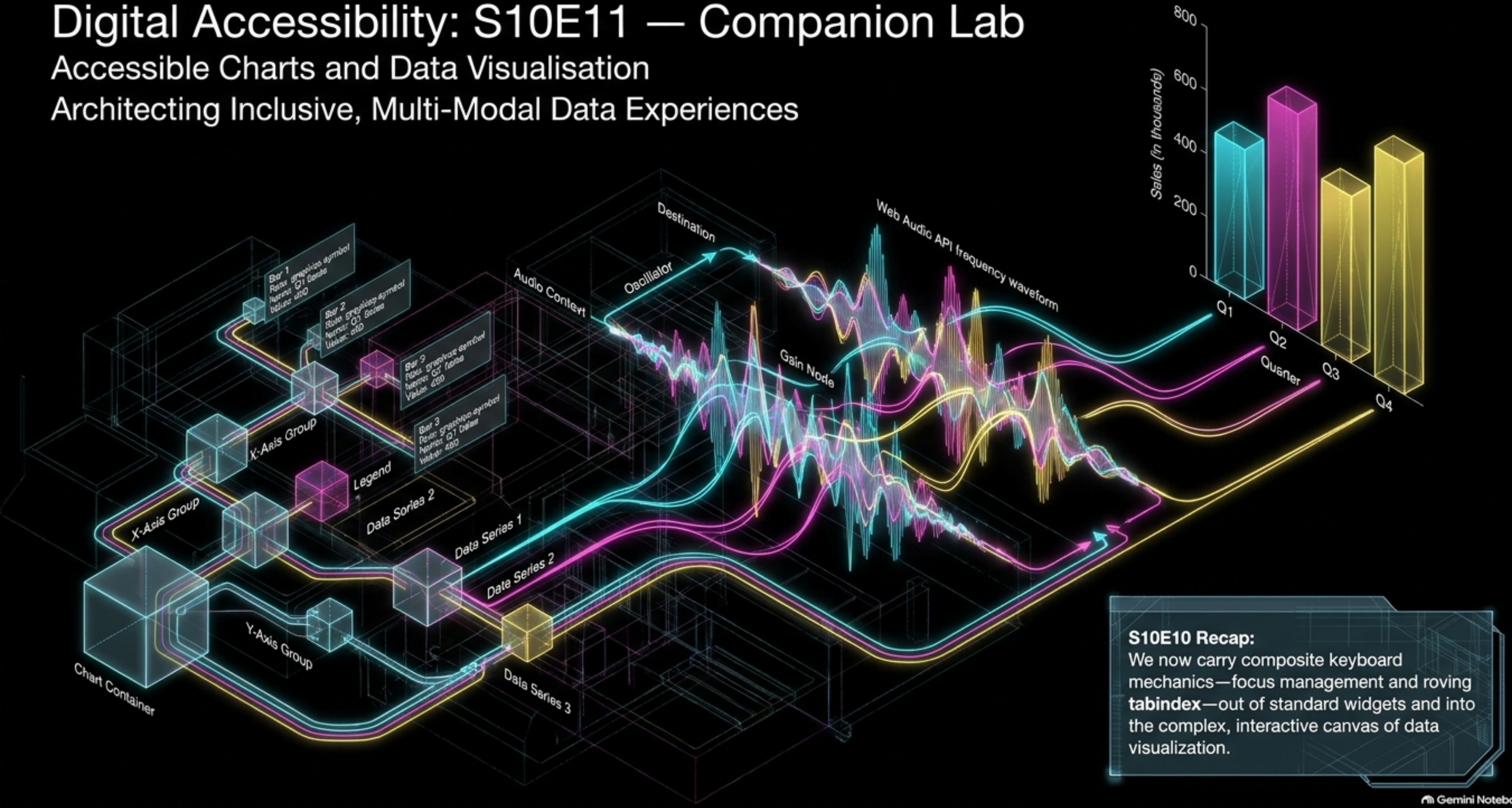
Digital Accessibility: S10E11 — Companion Lab

Accessible Charts and Data Visualisation

Architecting Inclusive, Multi-Modal Data Experiences

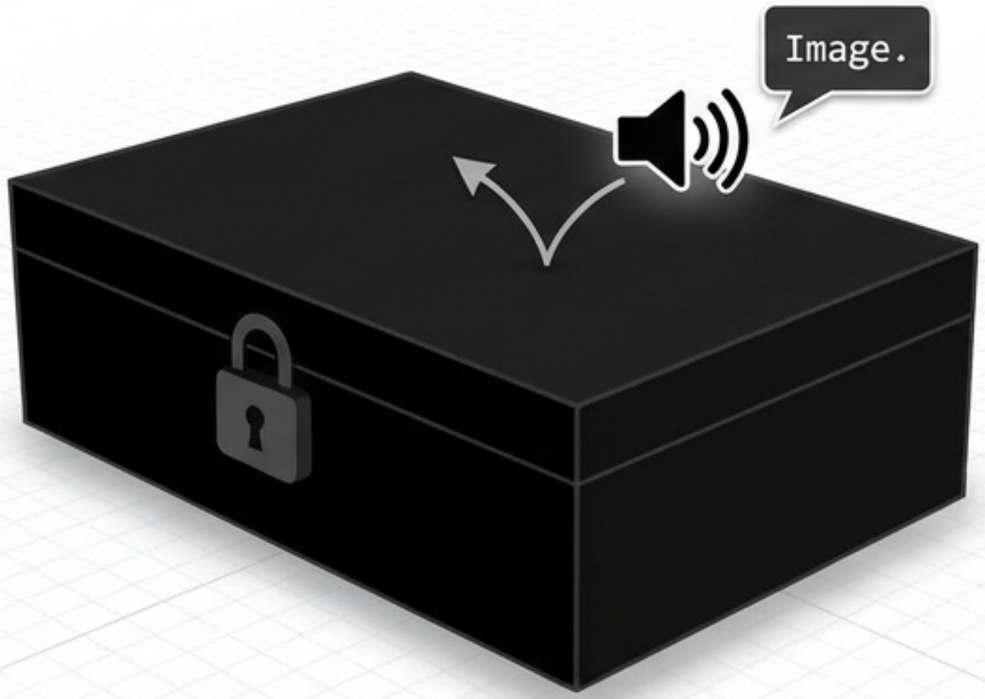


S10E10 Recap:
We now carry composite keyboard mechanics—focus management and roving **tabindex**—out of standard widgets and into the complex, interactive canvas of data visualization.

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1. The Rendering Chasm: Silent Bitmaps vs. Tick-Dumps

The <canvas> Void




```
<canvas id=chart></canvas>
```

Zero sub-DOM nodes. Renders as a flat bitmap. Screen readers perceive an empty image; screen magnifiers perceive blurry, pixelated scaling.

The Raw <svg> Noise




```
<svg><g><text>0</text><text>10</text>..../g></svg>
```

Unannotated vector outputs create a tick-dump. Screen readers read every gridline, axis tick, and data point as a linear, un-navigable string of disconnected numbers.

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Chartability (POUR-CAF): Redefining Inclusive Data

Accessibility in dataviz extends beyond WCAG. Chartability introduces 7 principles and 14 critical heuristics to prevent cognitive and functional failures.

Perceivable	Data in text is human-readable (e.g., 6.5 billion, not 6500000000).
Operable	Multi-modal discovery (keyboard, switch, voice).
Understandable	Purpose and how to read instructions explicitly provided.
Robust	Withstands aggressive scaling and custom stylesheets.
Compromising	Equivalent fallbacks (e.g., No table is a critical failure).
Assistive	Appropriate data density limits (reducing cognitive load).
Flexible	Tolerates varied user inputs and visual overrides.

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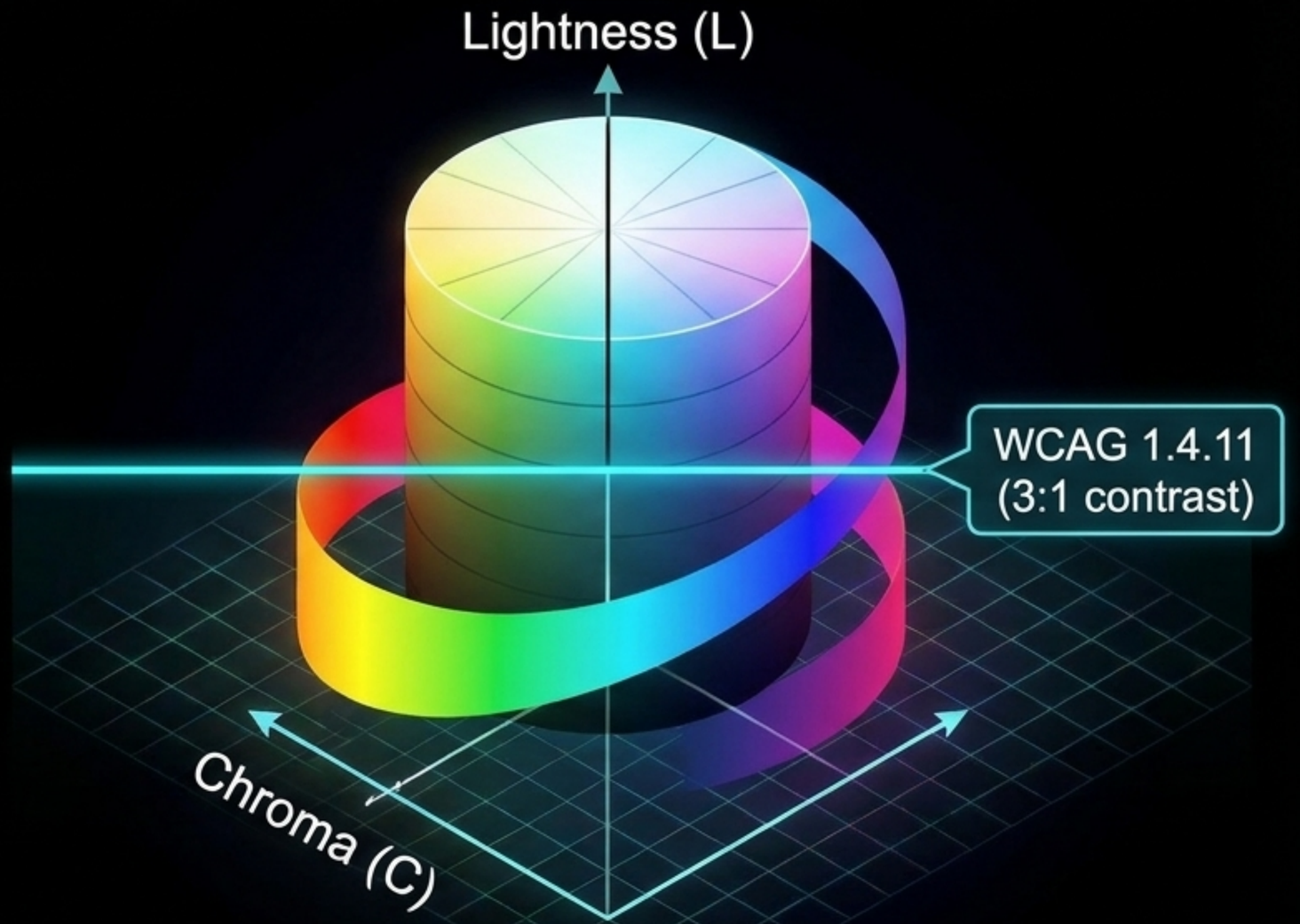
2. Multi-Channel Encoding: Beyond Flat Color

Color hue alone cannot carry data (WCAG 1.4.1). We must synthesize perceptual lightness with structural geometry.

OKLCH Perceptual Uniformity

Unlike HSL/RGB, oklch() allows us to step through hue while locking Lightness. This guarantees mathematical compliance with the 3:1 non-text contrast requirement for marks and slices across all data series.

```
fill: oklch(70% 0.15 240);
/* L locked at 70% */
```



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The Redundancy Engine: Color + Geometry + Typography

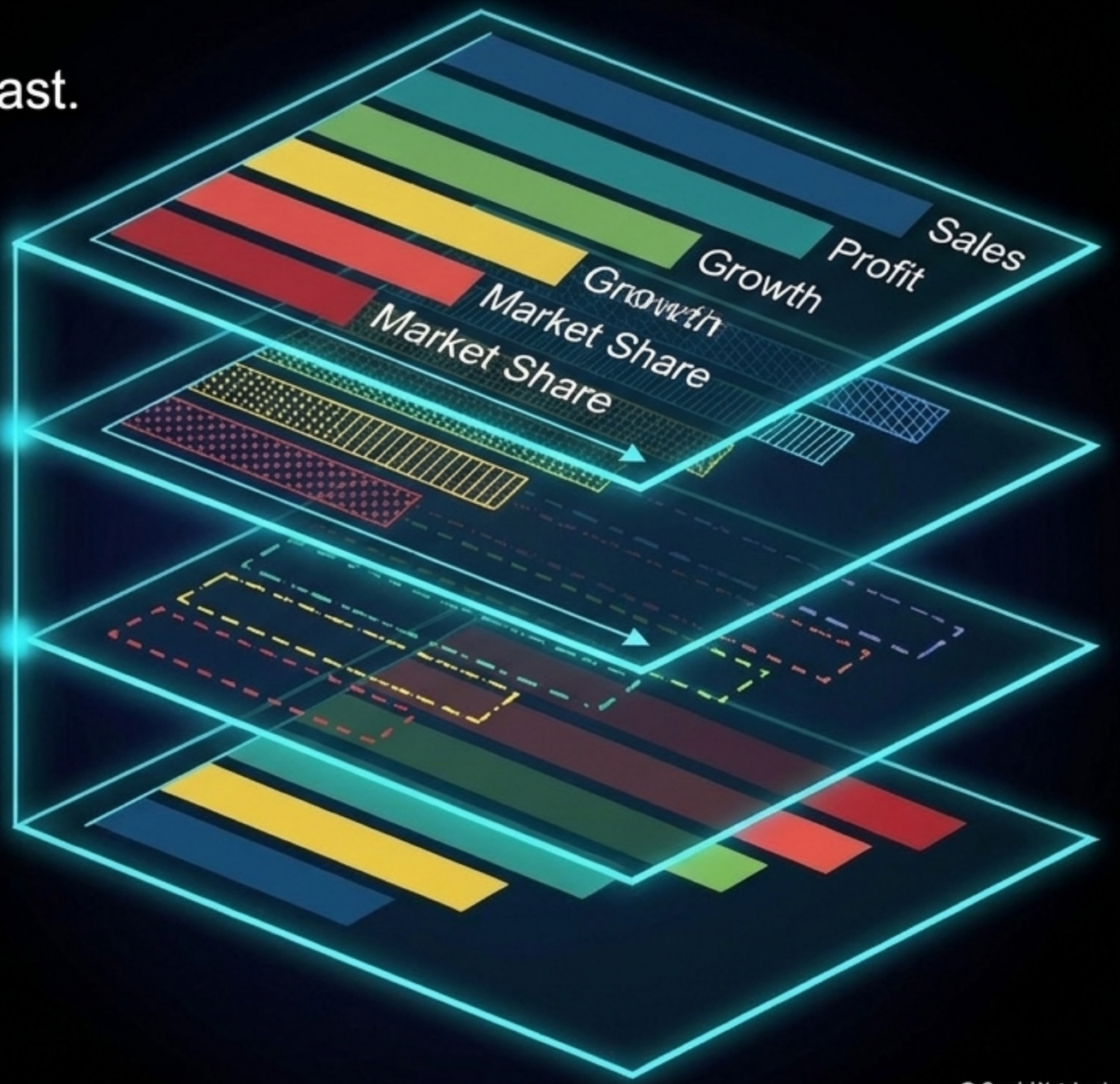
1. Perceptual Color: `OKLCH` ramps ensure distinct slices with guaranteed baseline contrast.

2. Stroke & Dash: `stroke-dasharray=8 4` and 2 4 differentiate trend lines structurally without relying on hue.

3. Shape & Texture: SVG `<defs><pattern>` overlays (dots, diagonals) on solid fills ensure clarity in grayscale or colorblindness.

4. Direct Labeling: Series labels are docked physically at the end of data lines, eliminating detached-legend eye gymnastics and cognitive load.

```
@media (forced-colors: active) {
  stroke: CanvasText;
}
```



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3. The 4-Tier Information Hierarchy

Layer A (Top): Narrative Context.
States direction, magnitude, and outliers upfront (e.g., P1 incidents dropped 38%).

Layer B: Noise Cancellation.
`aria-hidden=true` applied to silence decorative gridlines, raw axis ticks, and background fills.

Layer C: Semantic Structure.
Hierarchical ARIA and WAI-ARIA Graphics Module mappings ensuring reliable cross-AT translation.

Layer D (Bottom): Readout Banners.
Docked, non-obscuring text banners for hover/focus data readouts (avoiding clipped floating tooltips).



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SVG-AAM: Semantic DOM Architecture

We map raw vector math to structural meaning using the WAI-ARIA Graphics Module, ensuring assistive tech recognizes the relationships between shapes.



Annotation Rules: `aria-labelledby` linking to visible text is the modern best practice, bypassing the inconsistent AT support of the raw `<desc>` element.

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Roving Focus: Spatial Keyboard Navigation

Standard Tab is insufficient for dense data. We bring composite roving tabindex mechanics directly into the SVG.



Tab Key
Moves focus into the chart root (`graphics-document`).

Up/Down Arrows
Shifts vertical focus between distinct Data Series (e.g., 2025 Revenue vs. 2026 Revenue).

Left/Right Arrows
Walks sequentially along the Data Points within the active series (e.g., Jan -> Feb -> Mar).



Implementation: JS dynamically updates `tabindex=0` on the active `<g role=graphics-symbol>` while setting all sibling nodes to -1.

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4. Case Study: Operations Desk SLA Trend Chart

A critical dashboard tracking P1 SLA breaches. Here is why the default render fails the Chartability heuristics.

The 5-Modality Failure State:

- **Visual:** 1.5px red/green lines fail colorblindness and contrast checks.
- **Keyboard:** Hover-only tooltips are entirely unreachable by keyboard.
- **Screen Reader:** Utters a single word: Image.
- **Zoom:** Blurry pixelation at 400% scale; tooltips clipped by overflow: hidden.
- **Mobile/Switch:** Impossible to physically pinpoint exact data nodes with a tap or switch scan.



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The Fix: Visual & Keyboard Modalities

The upgraded, accessible SLA Trend Chart.

Visual Upgrades:

- Upgraded from canvas to layered **<svg>**.
- Double-encoded **oklch()** colors + SVG **<pattern>** fills applied to strokes.
- Line thickness increased to 3px; distinct markers added at data nodes.



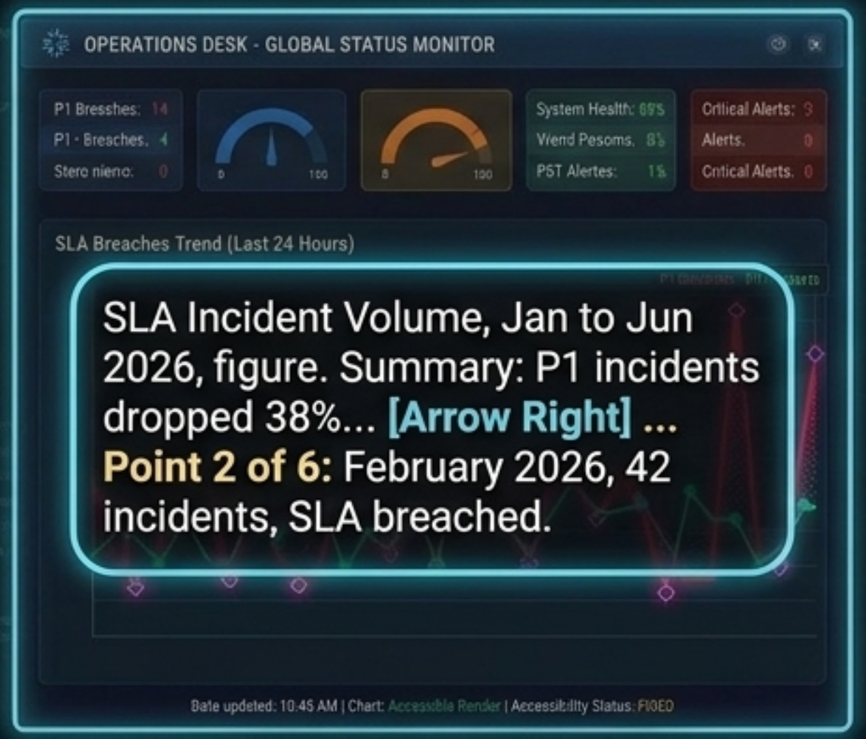
Keyboard Navigation Path:

- User presses **Tab** -> entire chart frame gains focus.
- User presses **Right Arrow** -> 2D halo activates on the January data point.
- User presses **S** -> Triggers Web Audio API sonification playback for the active series.

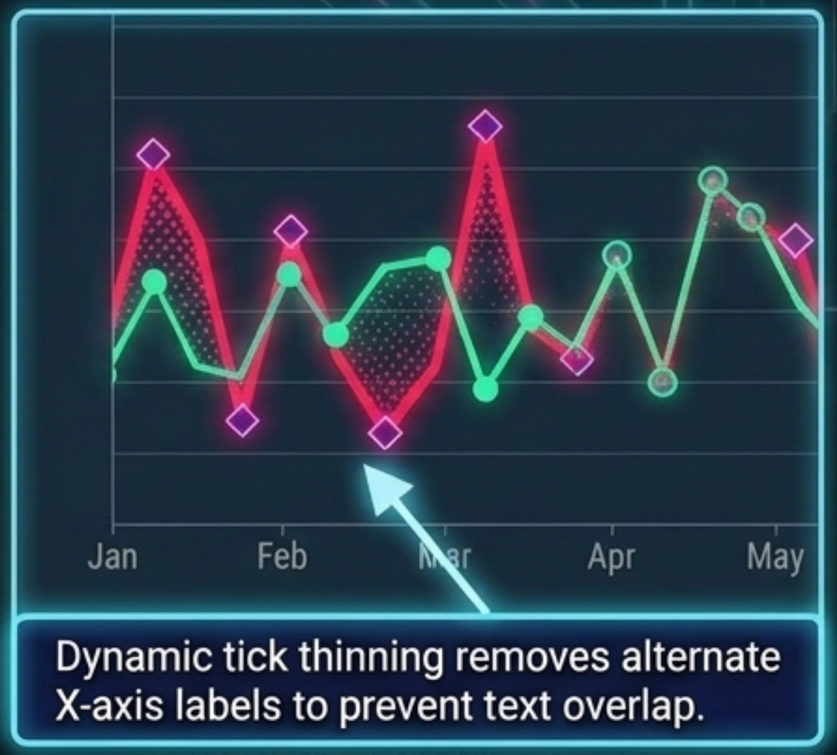
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The Fix: Screen Reader, Zoom, and Switch

Verbatim Screen Reader:



400% CSS Zoom:



The readout moves from a floating tooltip to a stacked, docked readout readout bar to prevent viewport viewport clipping.

Mobile/Switch:

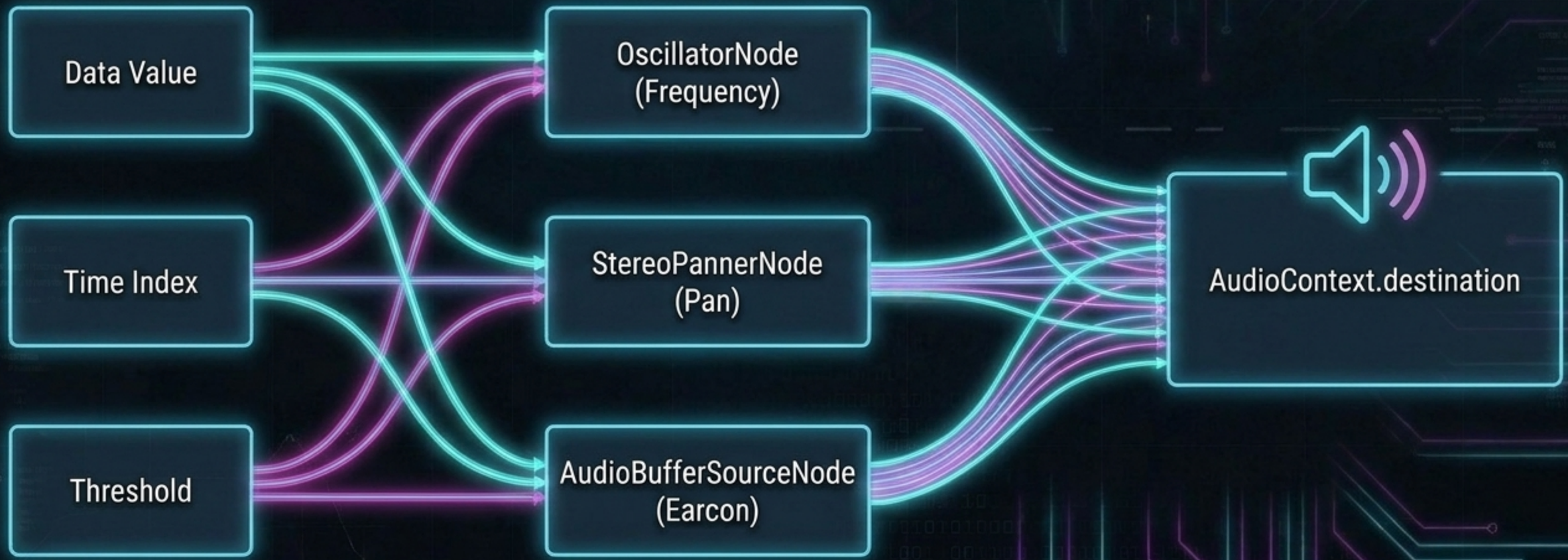


Tap-to-pin functionality added for touch. Switch users given a toggle to scan at the Series Level or Point Level.

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5. Data Sonification: Hearing the Trend

Drawing on concepts from Highcharts Sonification and Visa Chart Components, we translate quantitative data into aural space natively in the browser without third-party plugins.



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Mapping Values to Oscillators & Earcons

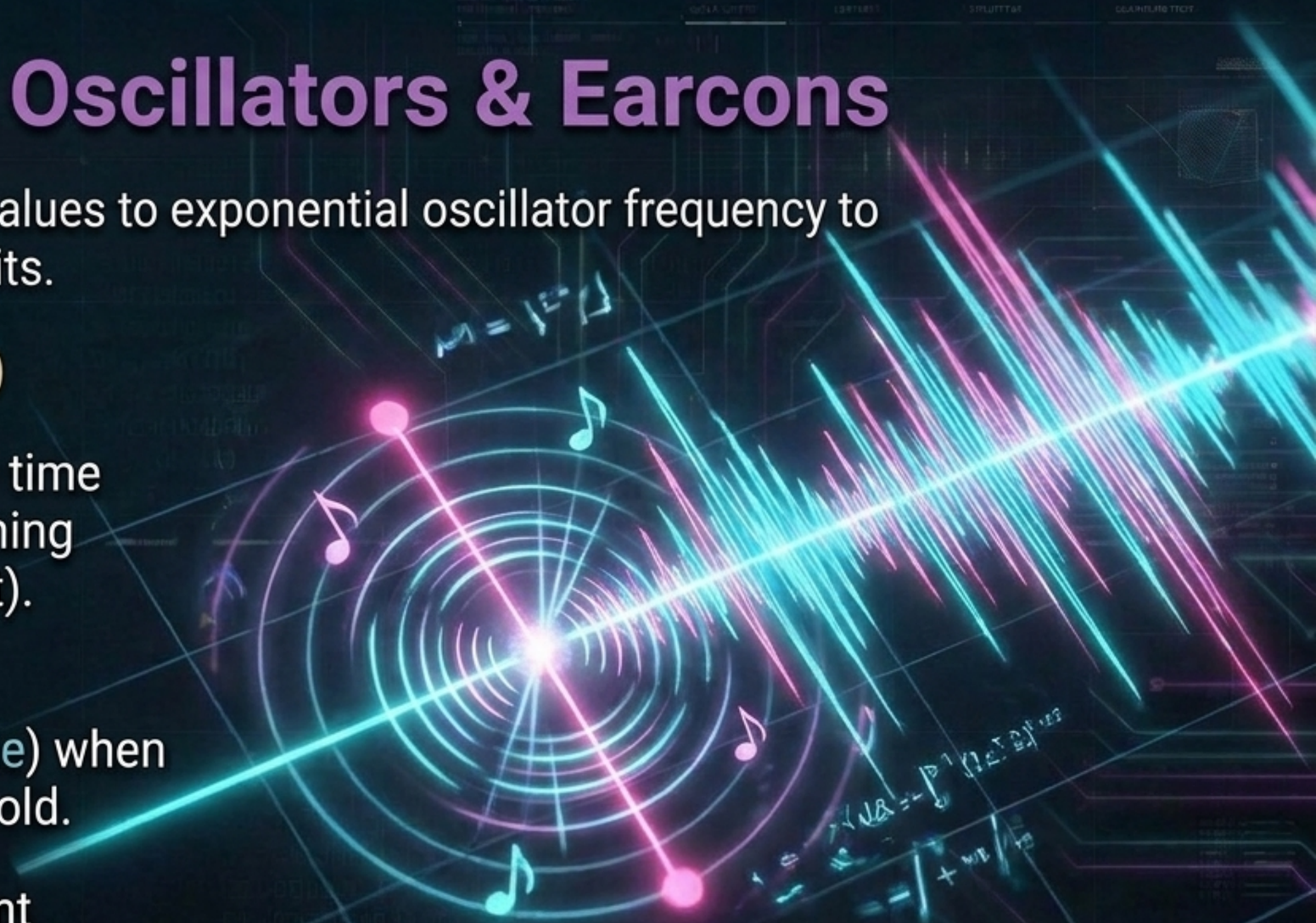
Pitch (Magnitude): Map quantitative values to exponential oscillator frequency to match human auditory perception limits.

220 * Math.pow(2, normalizedVal * 2)

Time (X-Axis): Map the chronological time index to the StereoPannerNode (panning seamlessly from -1.0 left to +1.0 right).

Earcons (Outliers): Trigger a distinct chime/chord (AudioBufferSourceNode) when a data point breaches the SLA threshold.

Critical Safety: Must include an instant Escape key stop trigger and user-controlled volume caps to prevent sensory overload or conflict with screen reader speech.

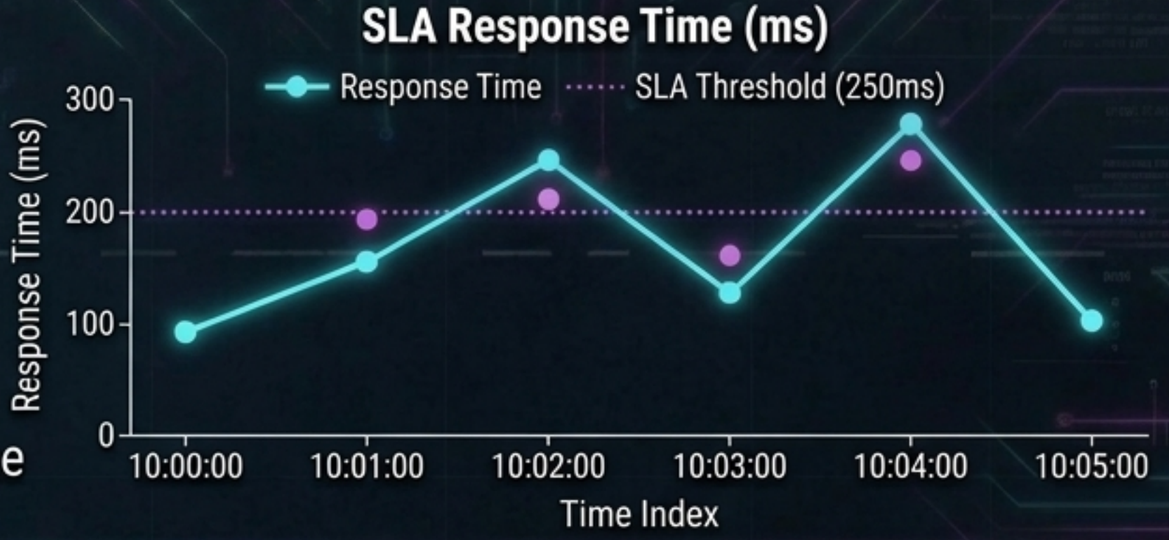


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6. The Escape Hatch: Synchronized Semantic Tables

Chartability principle Compromising mandates a table. A visualization is only fully accessible if the user can choose to bypass it entirely.

- **Semantic Structure**: Use <caption>, <th scope=col>, and <th scope=row> to establish rigorous grid relationships.
- **Complicated Data**: Use explicit id and headers attributes if the table requires multi-level scoping or complex merged cells.
- **Synchronization**: Generate the <table> DOM from the exact same data array driving the SVG to guarantee absolute parity.

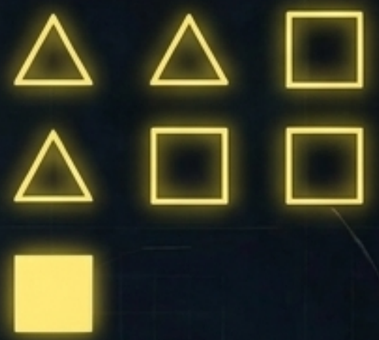


<caption>SLA Response Time Data (Synchronized)</caption>		
<th scope='col'>Time Index</th>	<th scope='col'>Response Time (ms)</th>	<th scope='col'>SLA Status</th>
<tr><th scope='row'>10:00:00</th>	<td>120</td>	<td>OK</tr>
<tr><th scope='row'>10:01:00</th>	<td>180</td>	<td>OK</tr>
<tr><th scope='row'>10:02:00</th>	<td>260</td>	<td>BREACH</tr>
<tr><th scope='row'>10:03:00</th>	<td>150</td>	<td>OK</tr>
<tr><th scope='row'>10:04:00</th>	<td>280</td>	<td>BREACH</tr>
<tr><th scope='row'>10:05:00</th>	<td>130</td>	<td>OK</tr>

Download CSV

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Production Ecosystems & Accessibility Capabilities

D3.js + Custom SVG	Observable Plot	Highcharts Accessibility	Visa Chart Components
Maximum control. Requires building ARIA structures, roving tabindex, and sonification completely from scratch.	Auto-generates basic aria-label and aria-description on SVG roots and marks. Excellent for static A11y, but requires custom wrappers for interactivity.	Industry-leading out-of-the-box support. Built-in sonification, robust pattern fills, and automatic semantic table generation.	Enterprise-grade. Deeply implements POUR-CAF heuristics, built-in keyboard navigation, and embedded keyboard instruction layers.
			

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7. Lab Exercise: Refactoring Pathway

The Challenge: Refactor Pathway's legacy <canvas> Weekly Study Minutes & Mastery Target dashboard component into a Chartability-compliant experience.

legacy-canvas-chart.js

```
const canvas = document.getElementById('studyChart');
const ctx = canvas.getContext('2d');

ctx.fillStyle = '#4A90E2';
ctx.fillRect(50, 250, 40, 100); // Mon
ctx.fillRect(110, 200, 40, 150); // Tue
ctx.fillRect(170, 280, 40, 70); // Wed
ctx.fillRect(230, 220, 40, 130); // Thu
ctx.fillRect(290, 190, 40, 160); // Fri

ctx.beginPath();
ctx.moveTo(50, 220);
ctx.lineTo(330, 220);
ctx.strokeStyle = '#E74C3C';
ctx.lineWidth = 2;
ctx.stroke();
```



Engineering Requirements:

1. Port the rendering engine from flat <canvas> to a 4-layer semantic <svg>.
2. Implement OKLCH perceptual colors and SVG <pattern> fills for target lines.
3. Inject graphics-document and graphics-object ARIA roles.
4. Sync the Web Audio API sonifier specifically for the Mastery Target trendline.
5. Render a perfectly synced <table id=study-data> below the chart UI.

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The 5-Point Verification & Next Steps

- [ ] **Visual**: Contrast >= 3:1 (OKLCH locked lightness) & multi-encoded (patterns/dashes).
- [ ] **Keyboard**: Roving focus across Data Series & Data Points.
- [ ] **Screen Reader**: 4-tier DOM hierarchy mapping SVG to AAM standard.
- [ ] **Zoom/Viewport**: 400% scale survival with dynamic thinning & docked tooltips.
- [ ] **Cognitive**: Explicit takeaway **<figcaption>** & strict data density limits.

Next Up (S10E12): Companion Lab: Native iOS and Android Accessibility



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