Towards enabling Secure Web-Based Cloud Services using Client-Side Encryption

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- Encryption via 3rd-party extension not feasible

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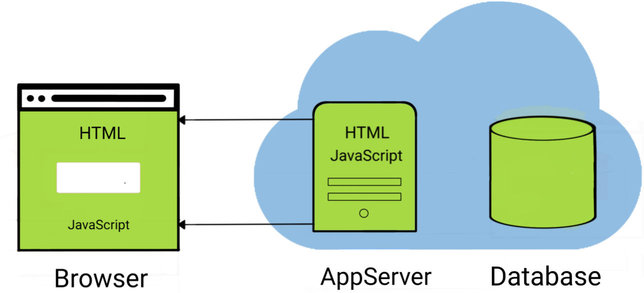
Database operator stores the user's data on behalf of the cloud operator

User utilized her web browser to access the application of the cloud operator

Web apps under fire!



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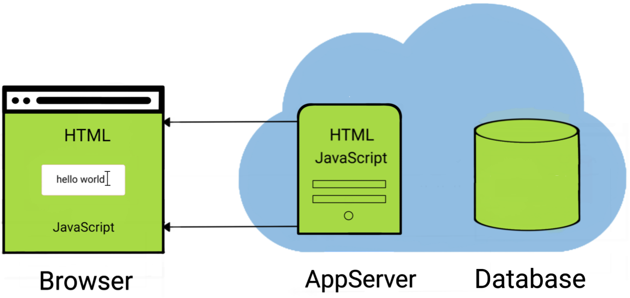

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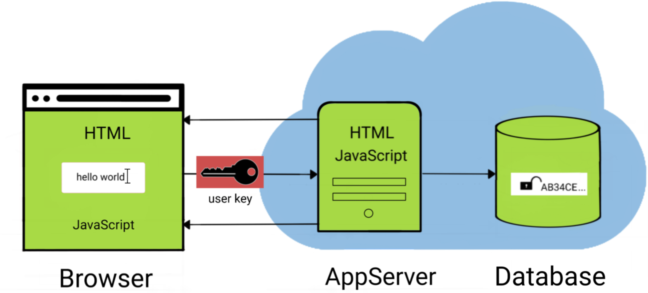

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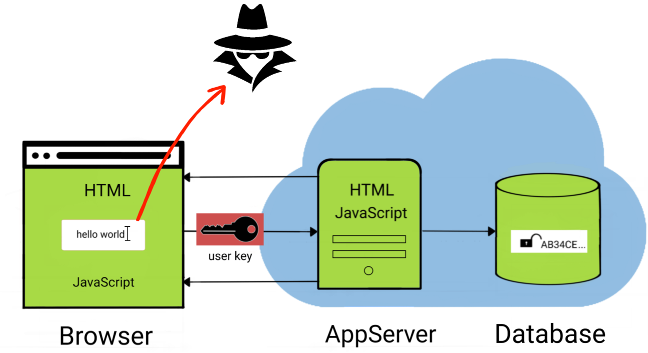

Web apps under fire!

Security Objective

The user want to keep her personal data private while still using the cloud operators web-based application.

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- Isolation against untrusted JS

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- Protection against malicious code injection

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Solution

Native encryption tools for web devs via new standarized DOM elements

CryptoMembranes (CM)

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1. Usage of CM DOM elements directly in HTML

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   (e.g. DIV → CryptoDIV)

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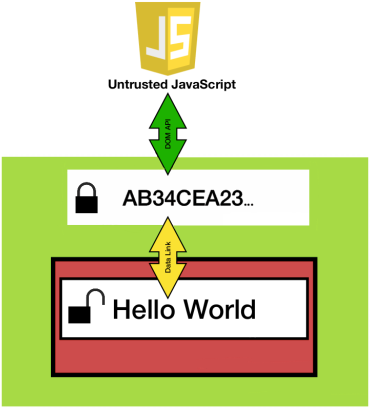
6. Cipher displayed to website JS

CM Details


Untrusted JavaScript
DOM API
AB34CEA23...
Data Link
Hello World

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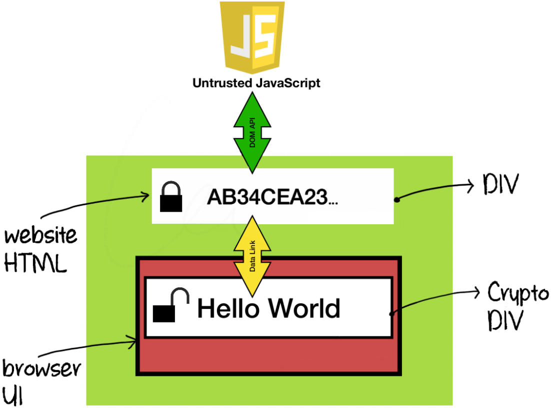
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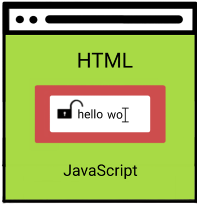
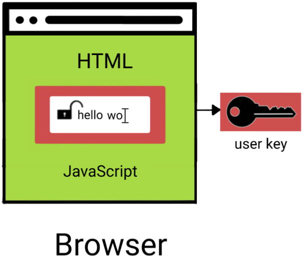
CM Architecture: Encryption



Browser

CM Architecture: Encryption



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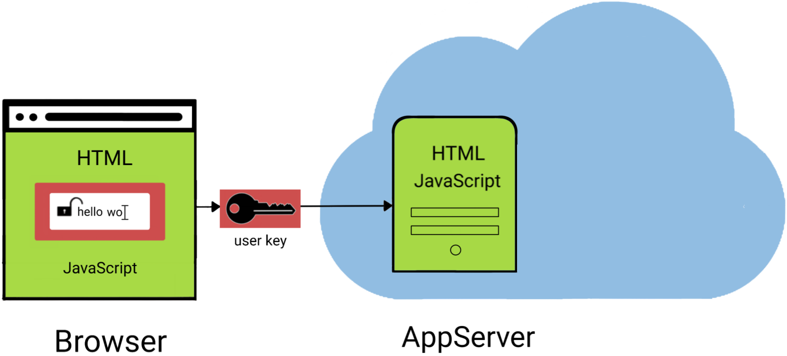

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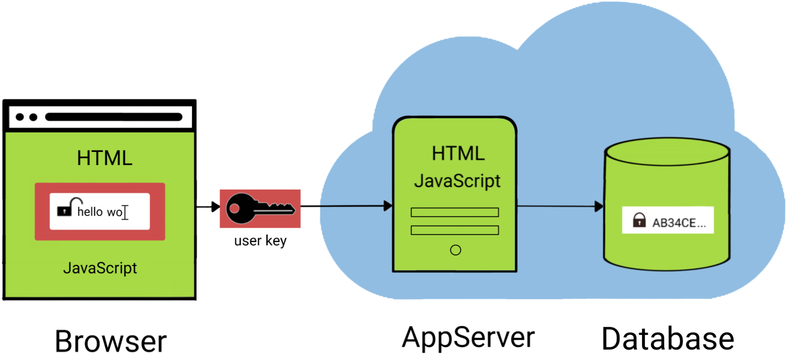
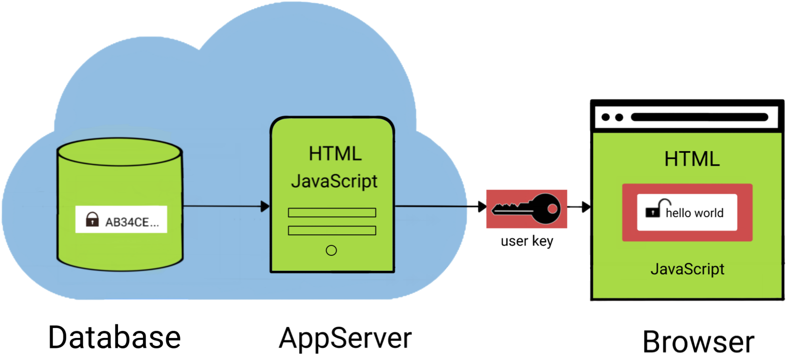


CM Architecture: Decryption



CM Details: Display

HTML Elements for data output:

```
<DIV> AB34CEA23...</DIV>
```

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HTML Elements for data output:

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<DIV> AB34CEA23...</DIV>
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Corresponding CM element:

```
<CryptoDIV CMKeyID="123" CMAlgID="OrderPreserving">
AB34CEA23...
</CryptoDIV>
```

CM Details: Input

HTML Element for data entry:

```
<INPUT Type="text" Name="confinput">
```

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HTML Element for data entry:

```
<INPUT Type="text" Name="confinput">
```

Corresponding CM element:

```
<CryptoINPUT Type="text" Name="confinput" CMKeyID="345"
↪ CMAlgID="Deterministic">
```

Client-Side Programming

```
<CryptoDIV ID="CM1" CMKeyID="911" CMAlgID "Deterministic">
</CryptoDIV>

<CryptoINPUT ID="CM2" Type="text" name="conf" CMKeyID="911"
↪  CMAlgID="Deterministic" onchange="moveData()">

<script>
function moveData(){
    var cm1 = document.getElementById("CM1");
    var cm2 = document.getElementById("CM2");
    var cValue = cm2.value   // cValue is encrypted
    cm1.innerText = cValue;
}
</script>
```

Legacy Browser Support

Extension-based support of CryptoMembranes

1. Identifying all CM elements in HTML
2. Insertion of CMs secure compartments

ExtensionMembranes: Workflow

intercept HTTP response

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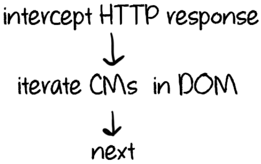


intercept HTTP response

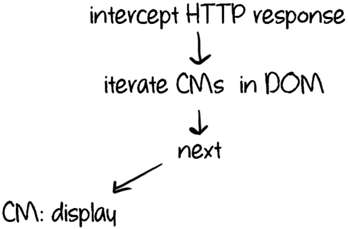
↓

iterate CMs in DOM

↓

next

ExtensionMembranes: Workflow



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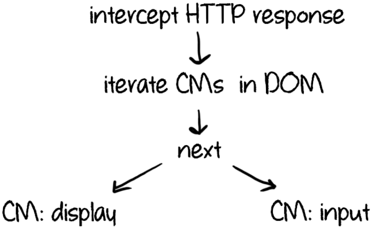

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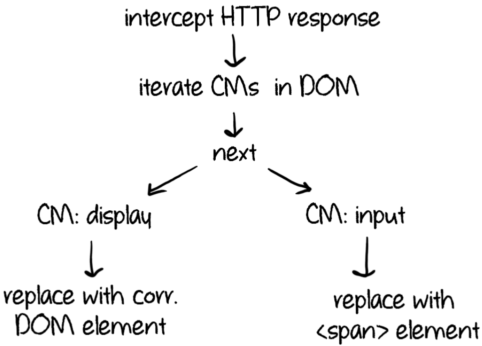

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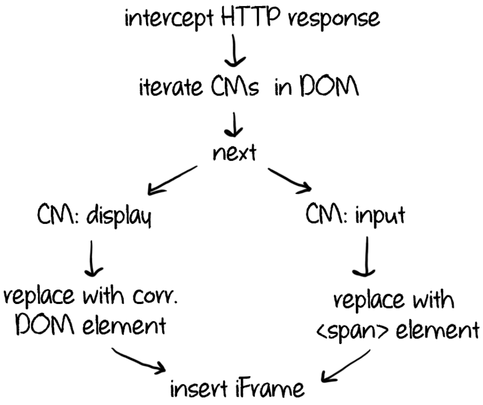

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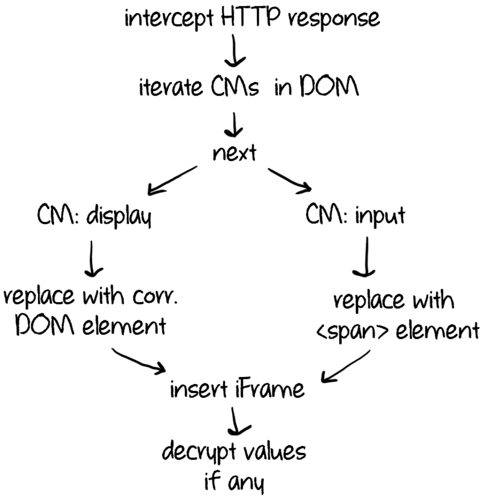

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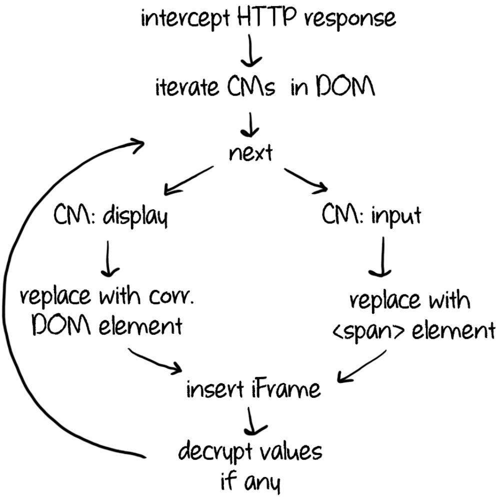

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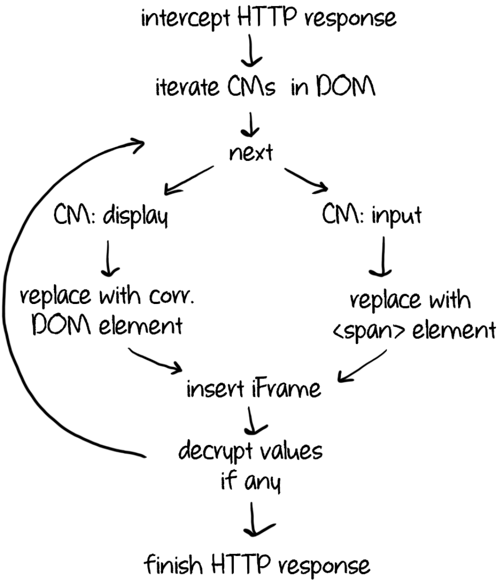

Security Assessment

- □ Isolation properties
- □ Protection against code injection
- □ Protection against UI-redressing attacks
- □ Incremental Deployability

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Security Assessment & Conclusion

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Future Work

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□ Native browser implementation

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□ User study on secure input / visual indicator

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- □ Native browser implementation
- □ User study on secure input/visual indicator
- □ Identifying crypto needs
  (Order preserving? Searchable? Aggregated?)

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