Tracing Your Roots: Exploring the TLS Trust Anchor Ecosystem

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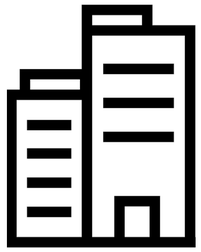
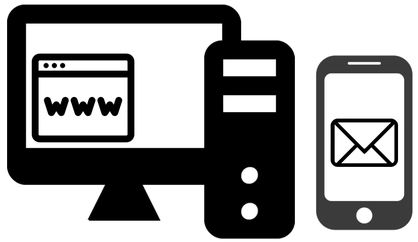
TLS + Web PKI



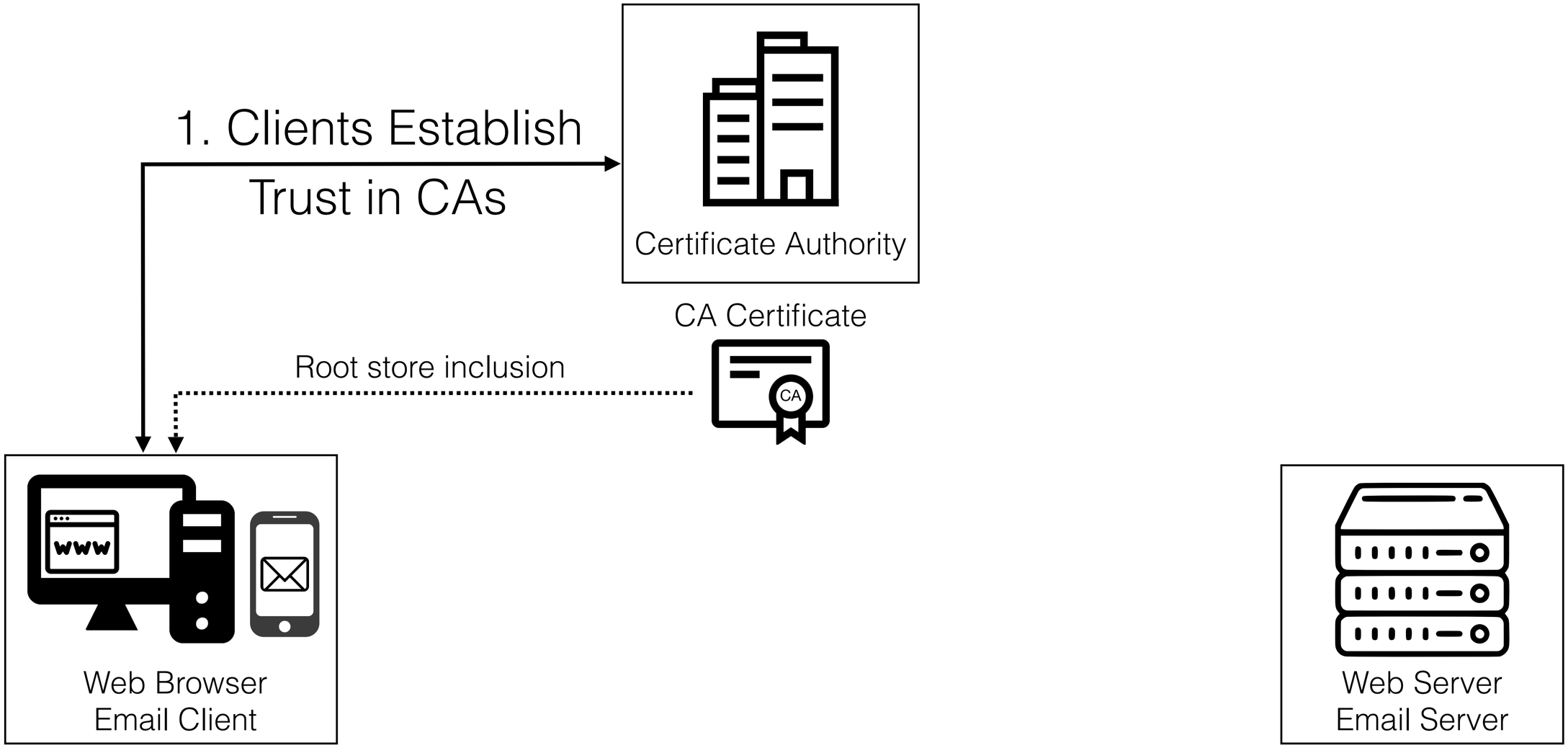
Certificate Authority



Web Browser
Email Client

Web Server
Email Server

TLS + Web PKI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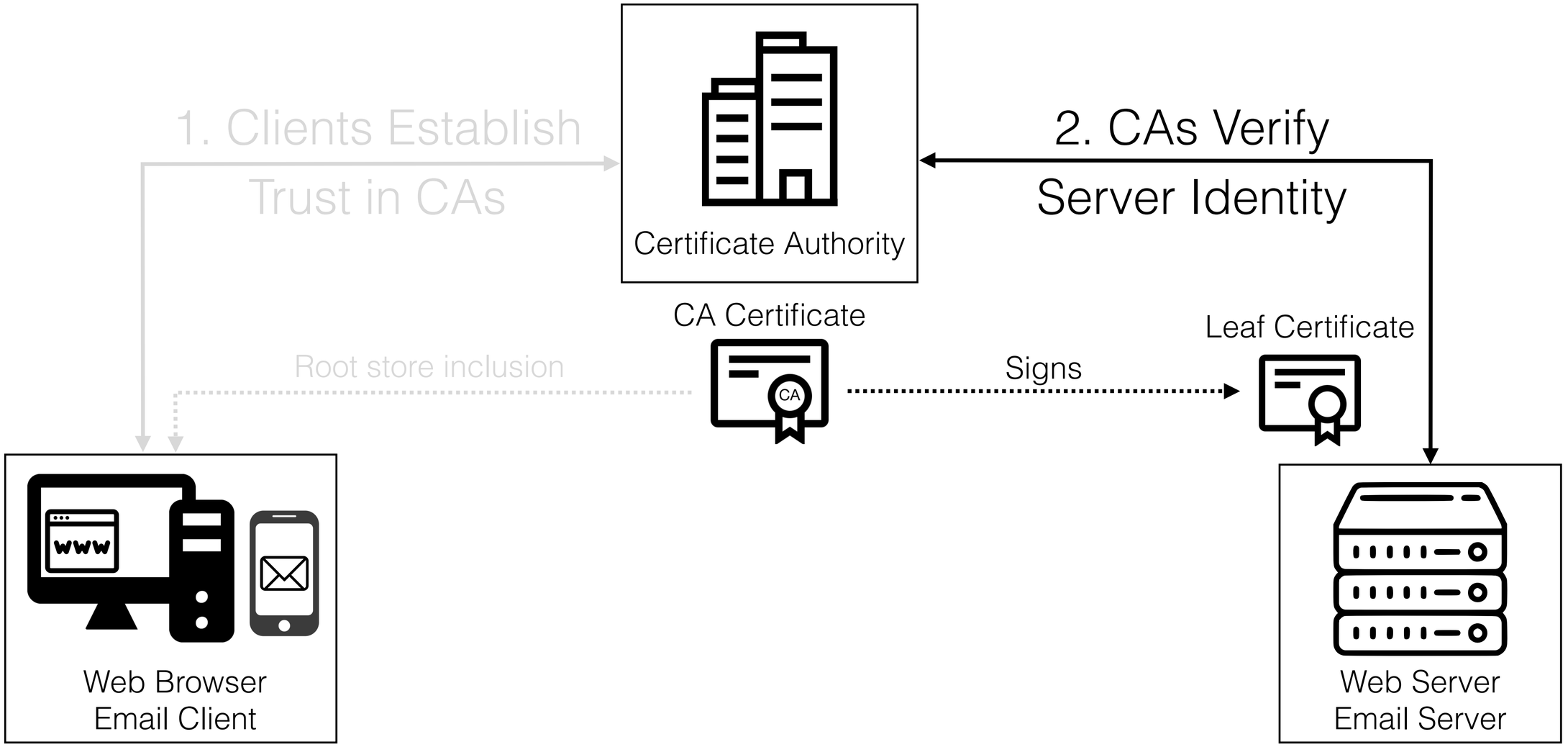
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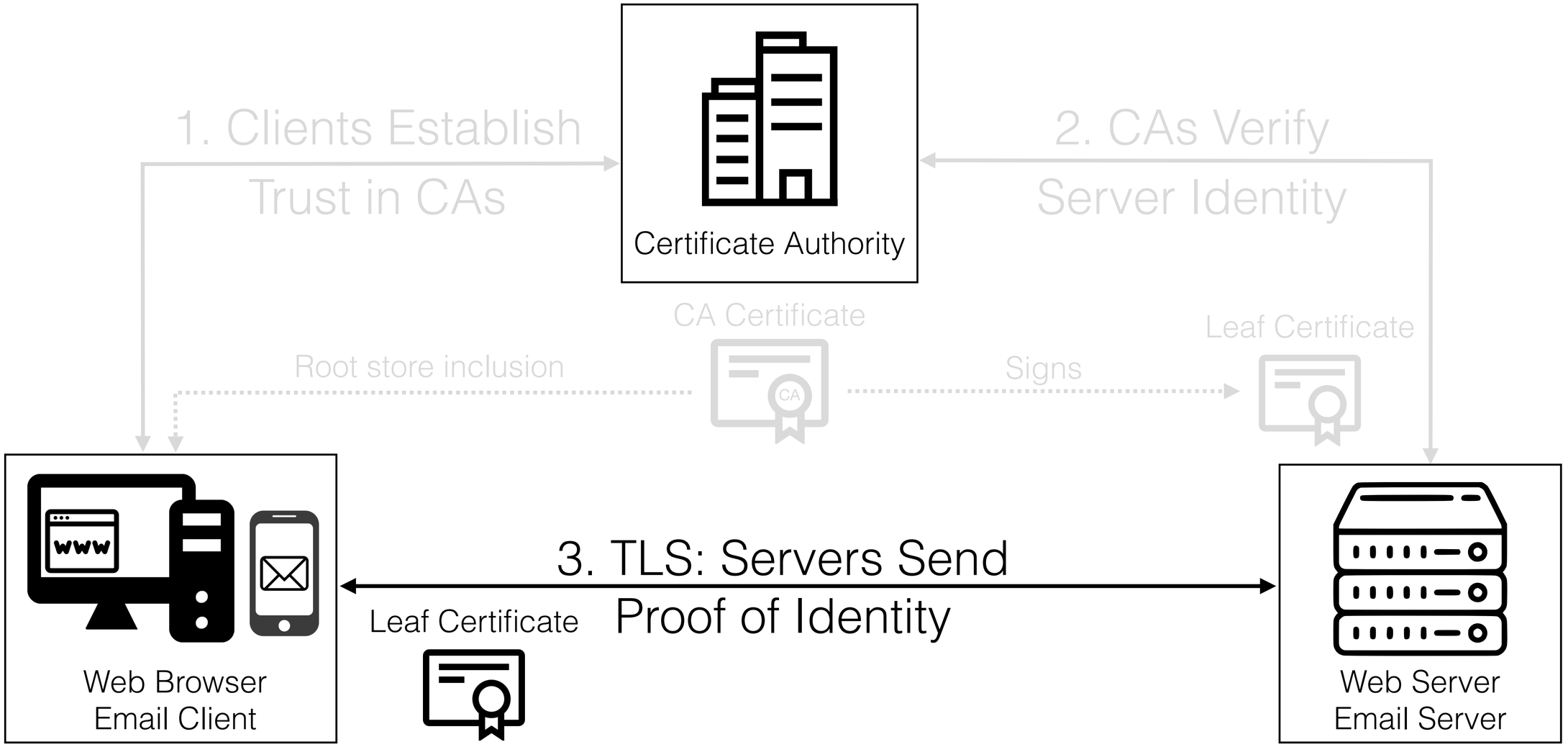
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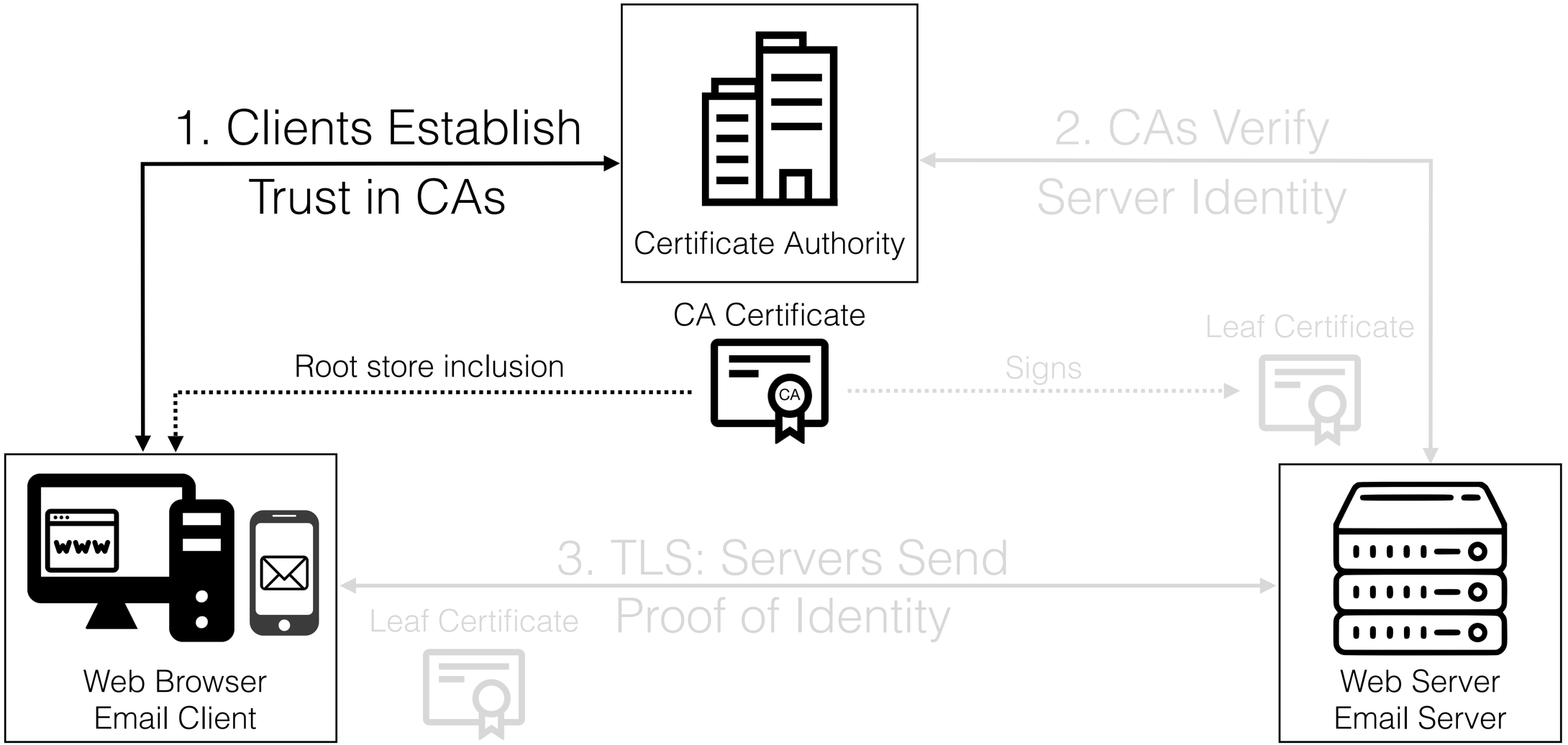
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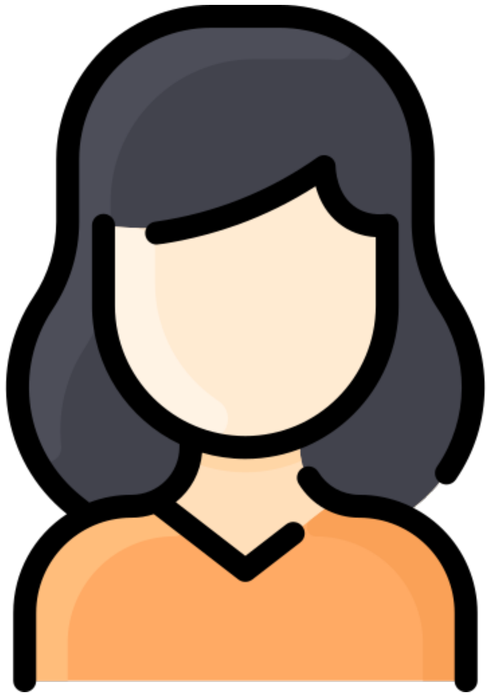
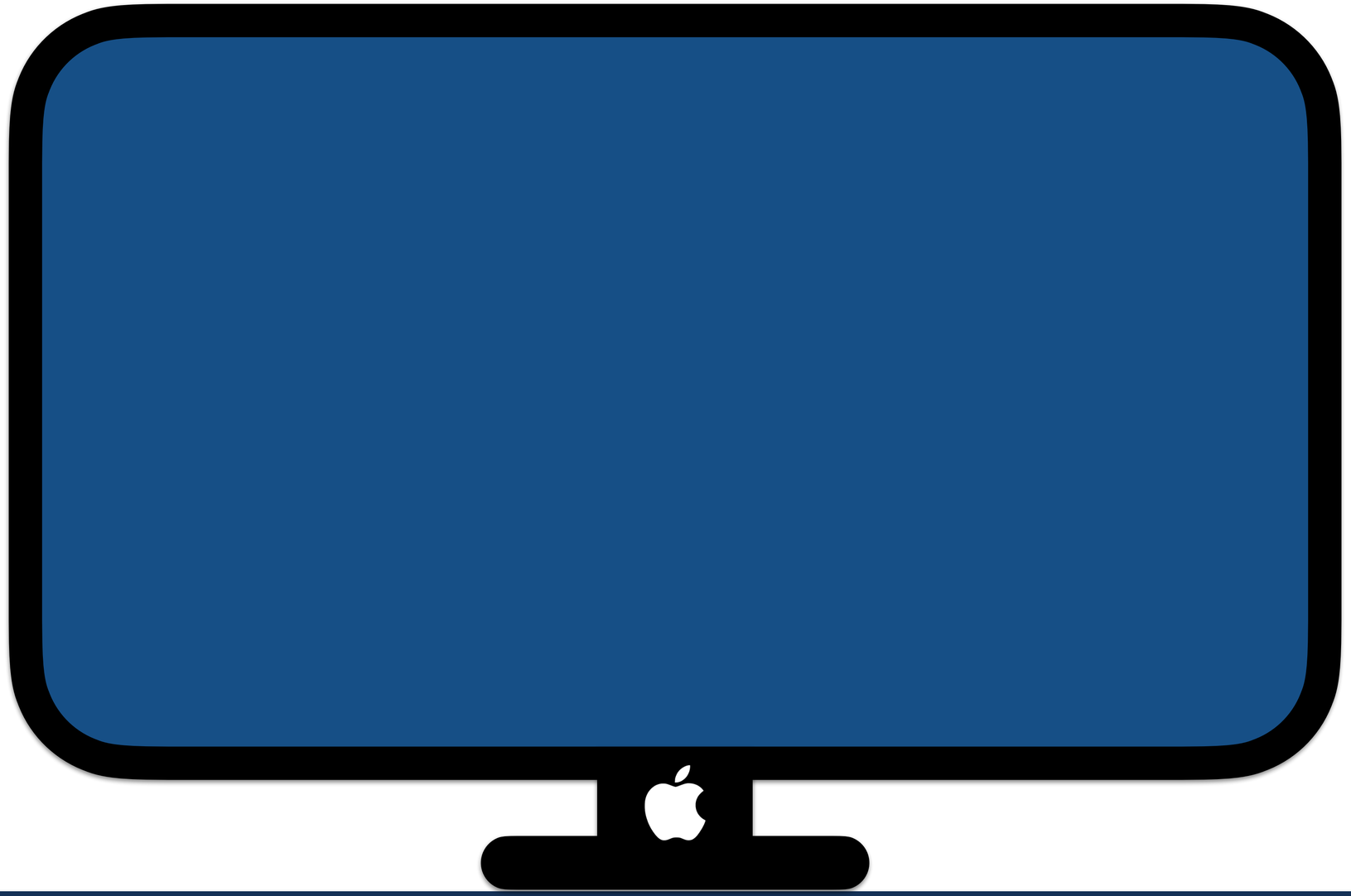
TLS user agents





TLS user agents

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Research Questions

1. Which root store providers do TLS user agents rely on?

2. How do root store providers determine which CAs to trust?

3. Characterization of root store programs

4. How faithfully do providers copy root program trust?

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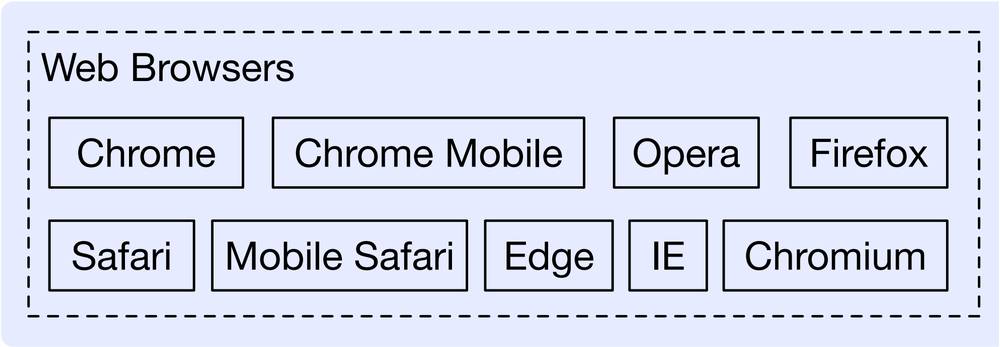
Data collection

User Agents



Collected root stores for 77% of global CDN top 200 user agents

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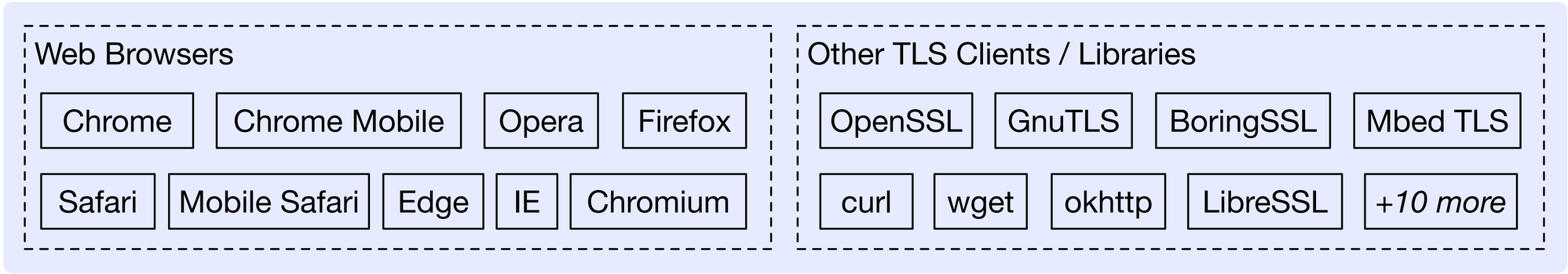
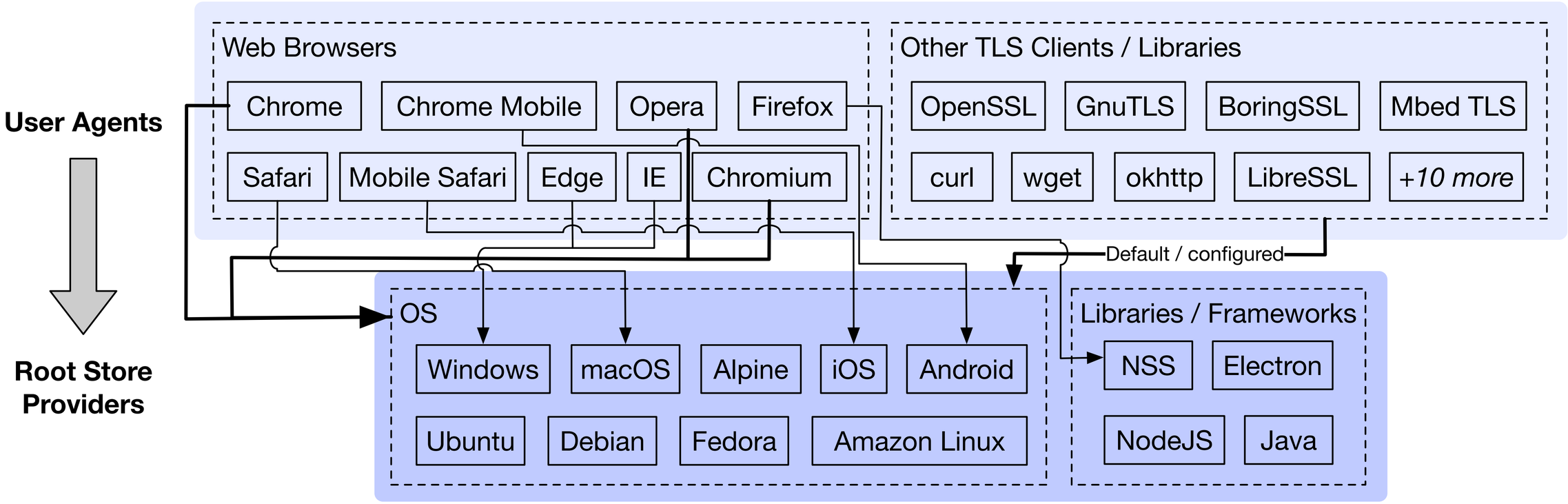


Collected root stores for 77% of global CDN top 200 user agents

Determined default root store for dozens of libraries / TLS clients

Root store providers



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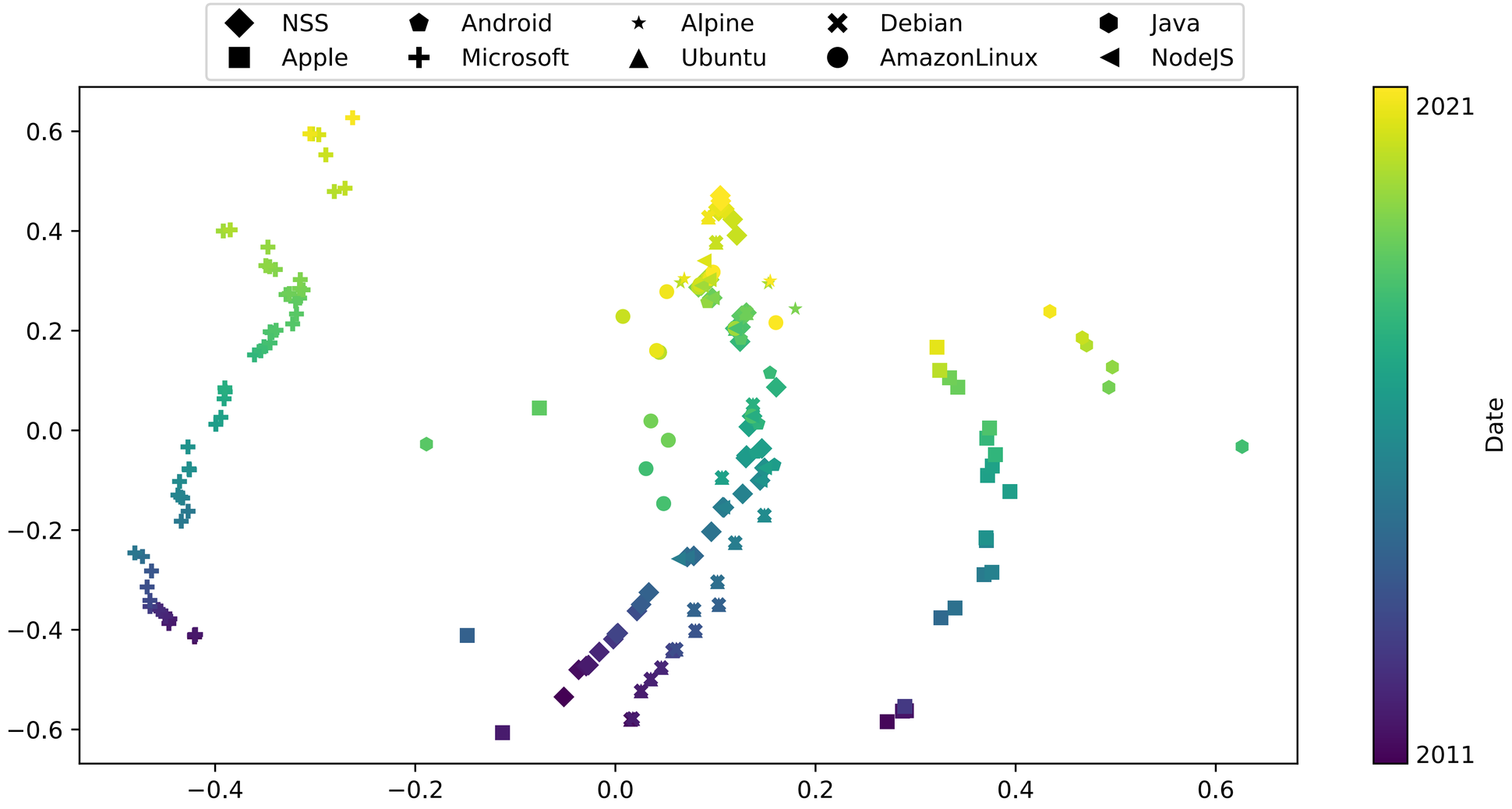
Clustering providers

metric MDS



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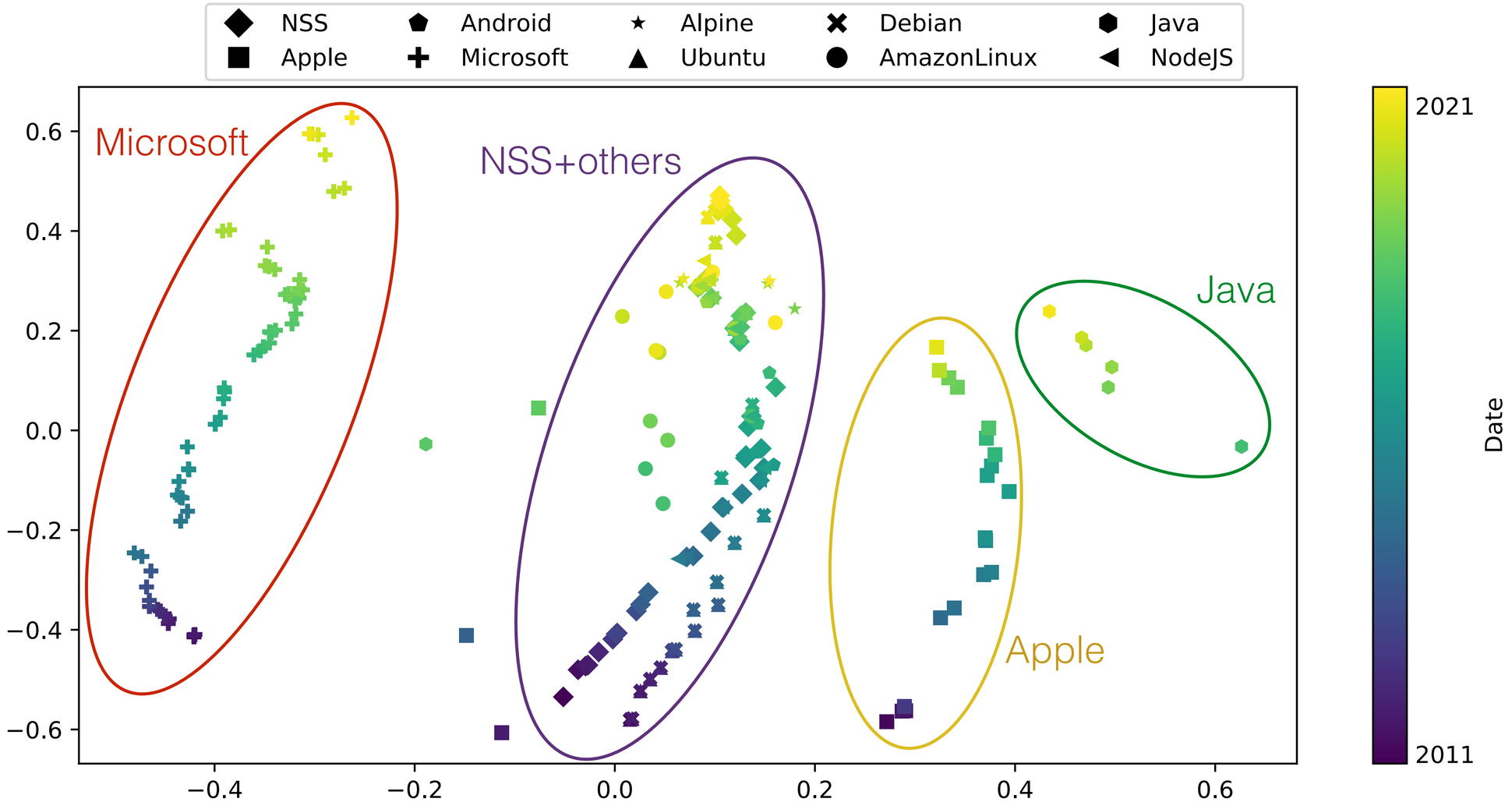

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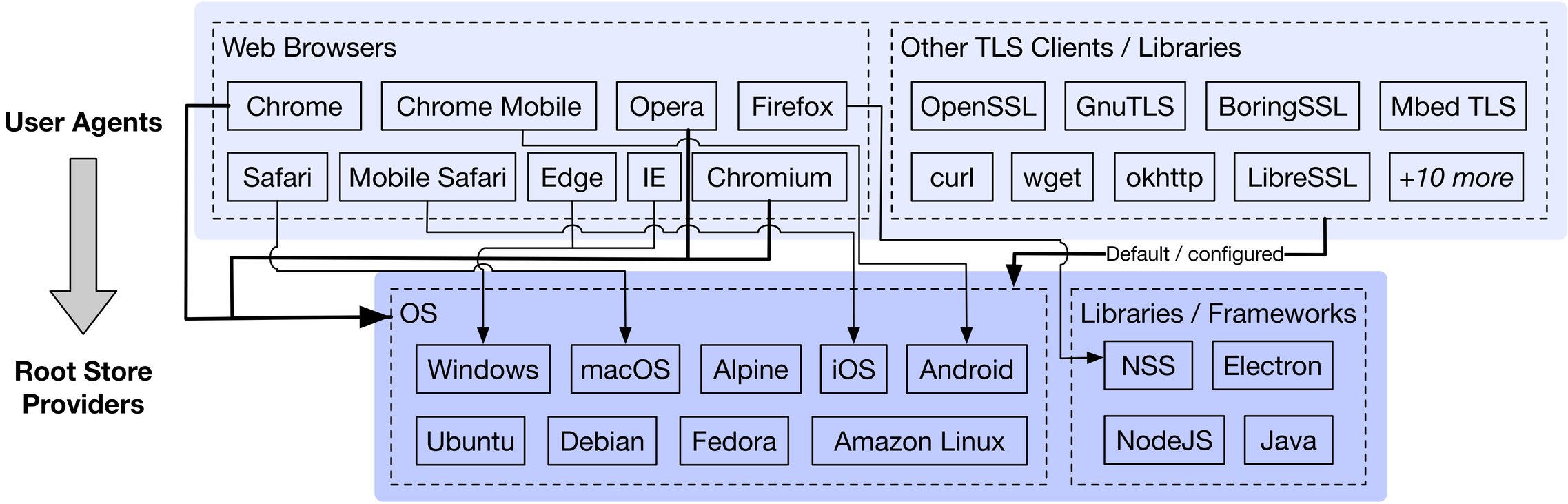
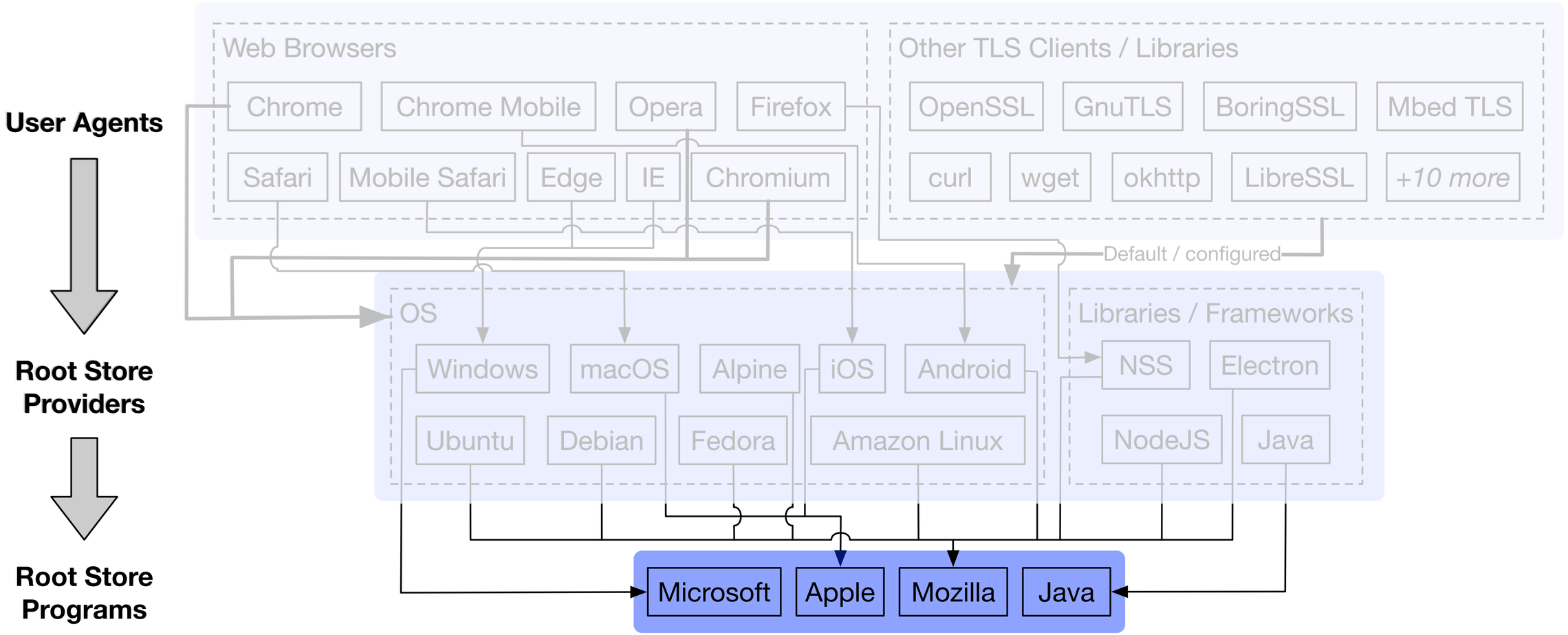


Root store programs



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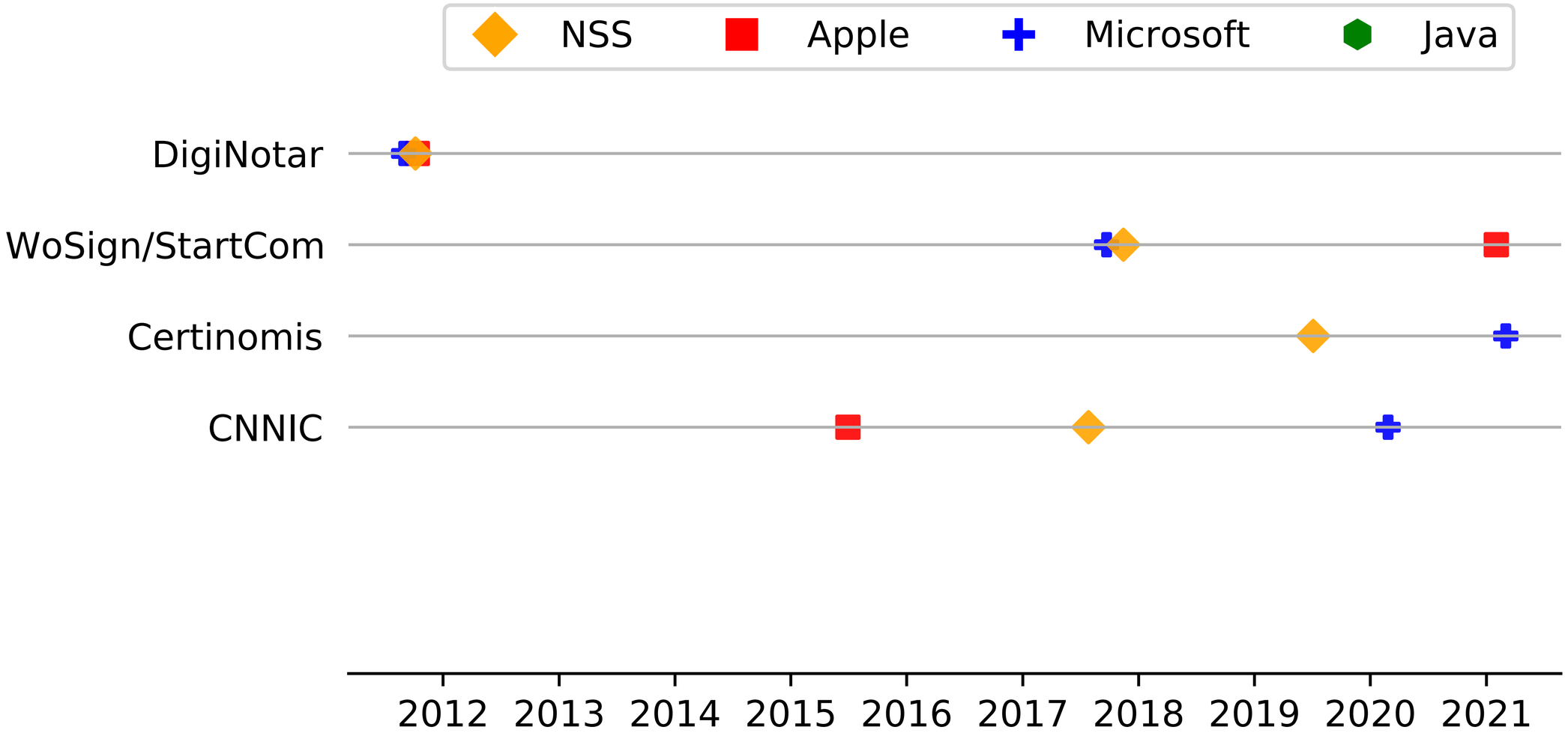

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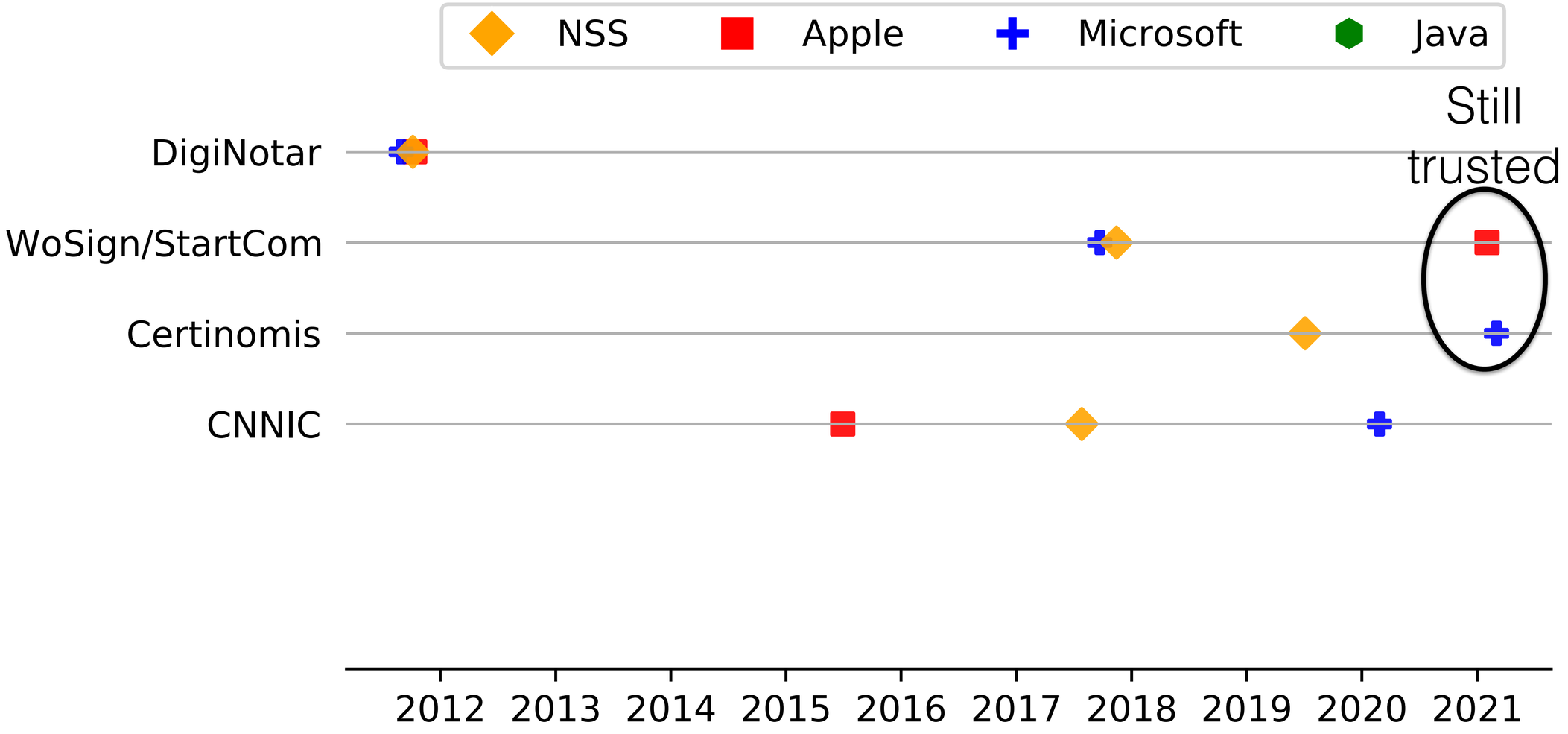

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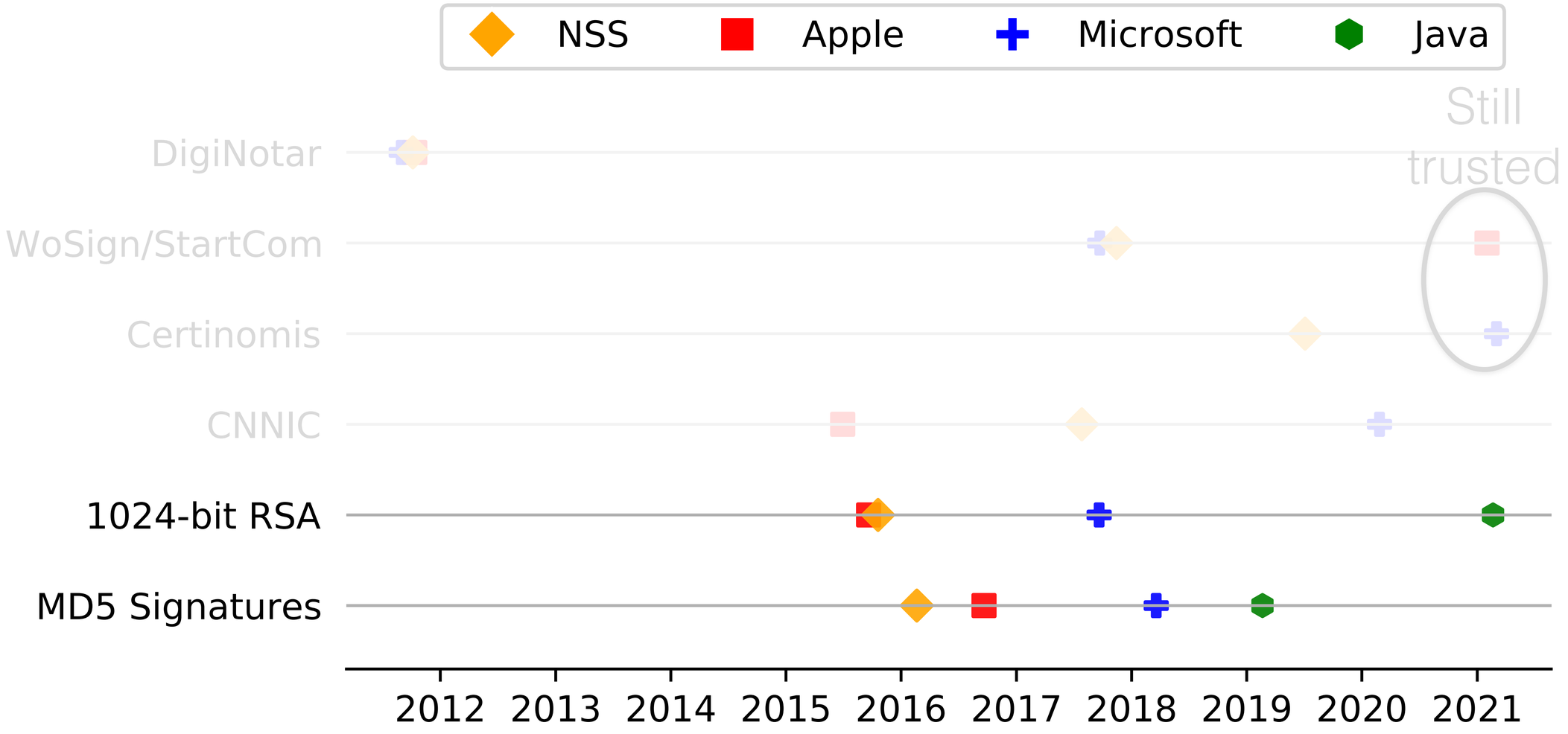

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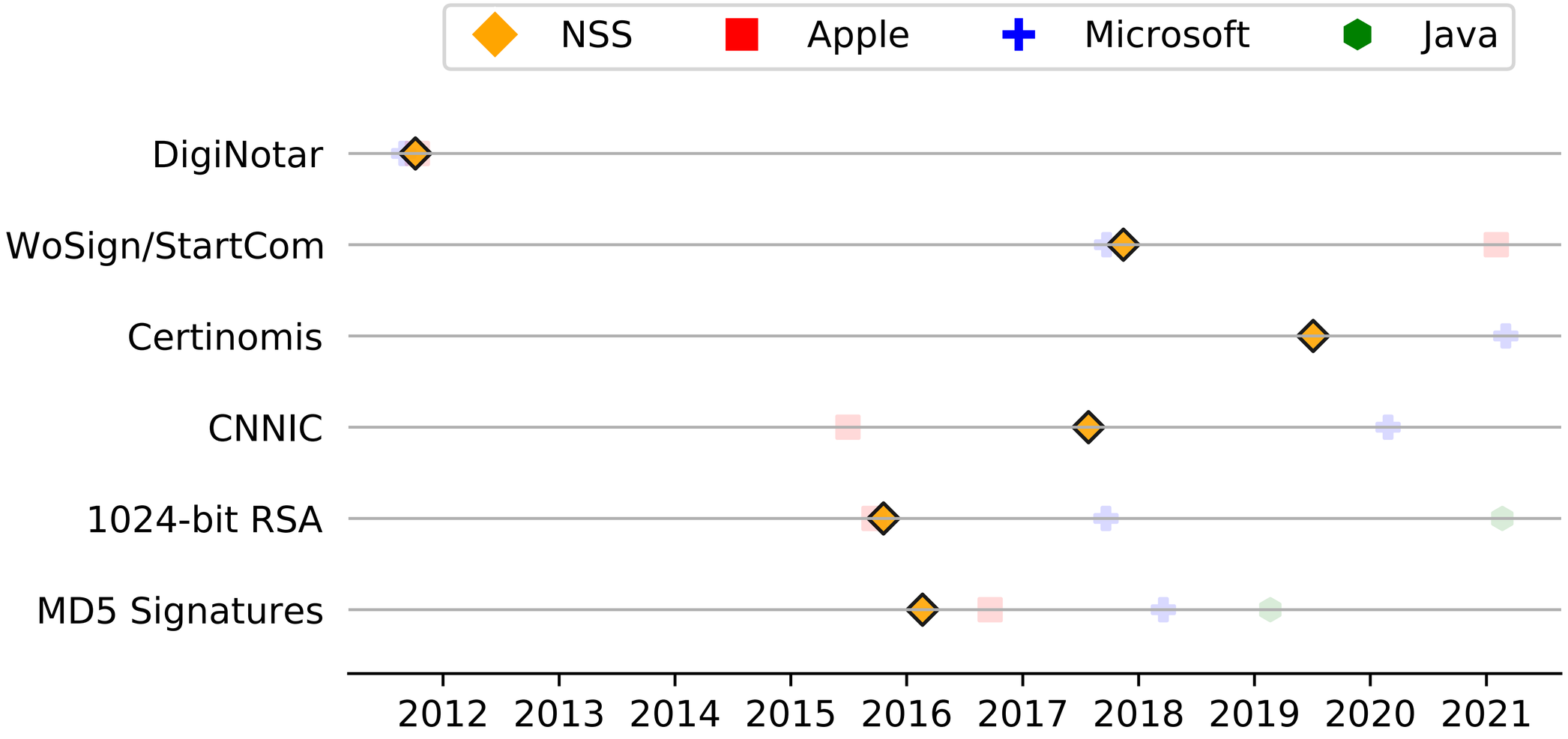

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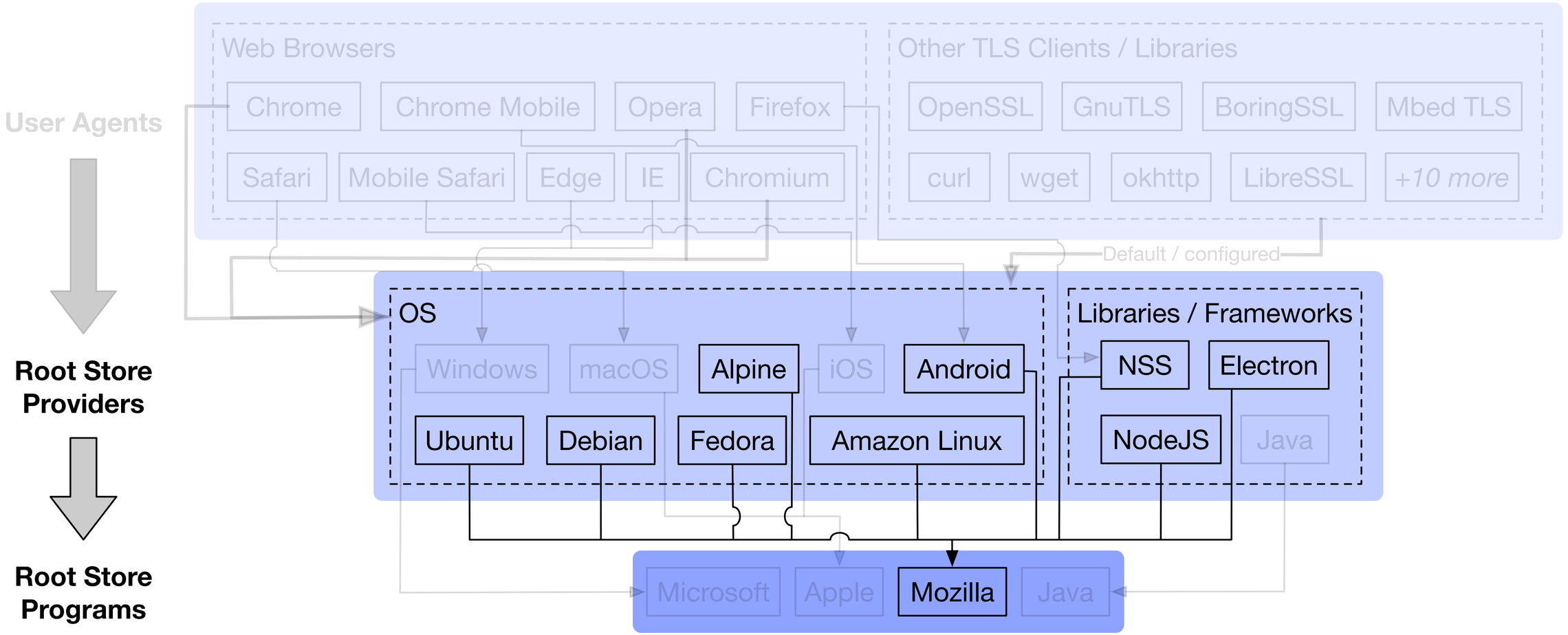
3. Size: Mozilla < Apple < Microsoft; Mozilla most restrictive, Microsoft allows government super-CAs.

4. Mozilla runs the most transparent root store program.

Mozilla derivatives



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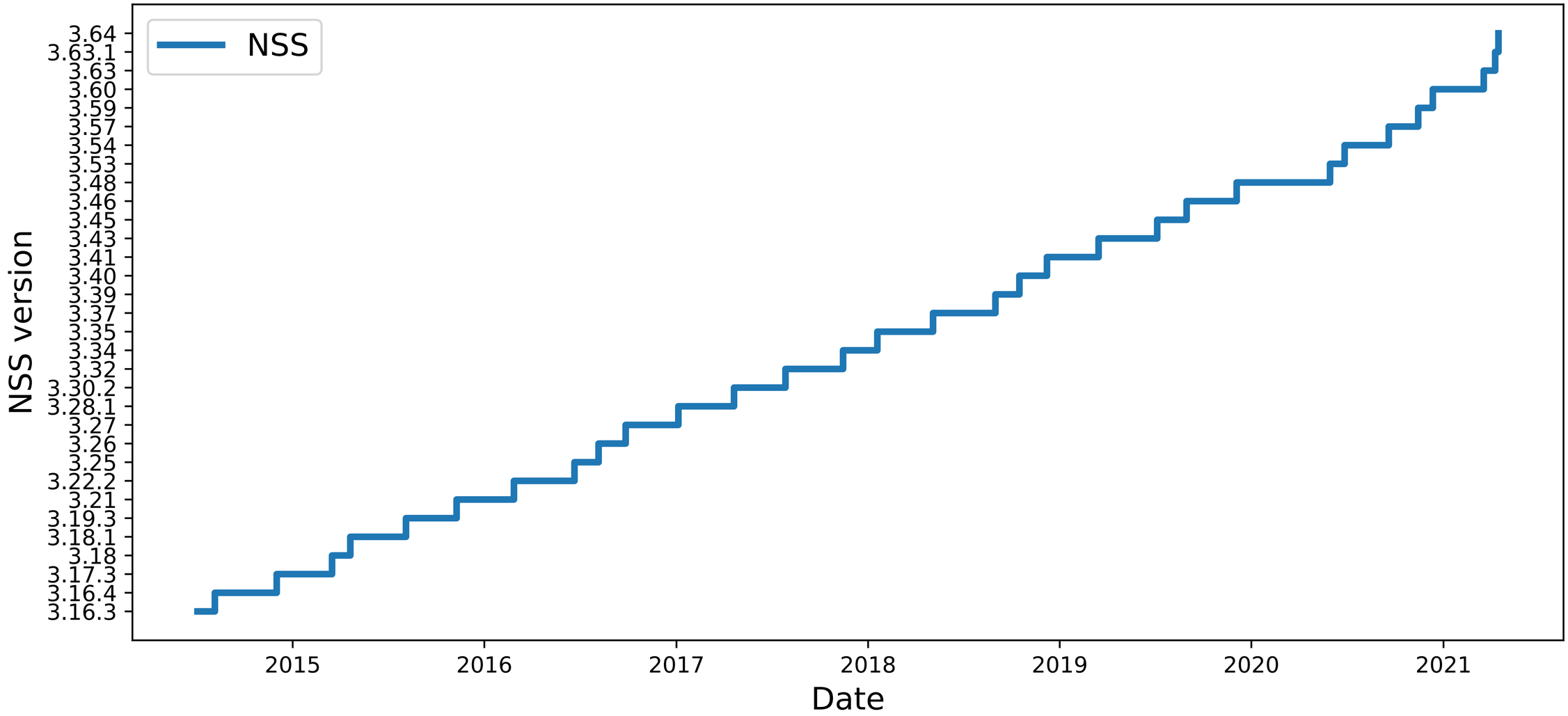

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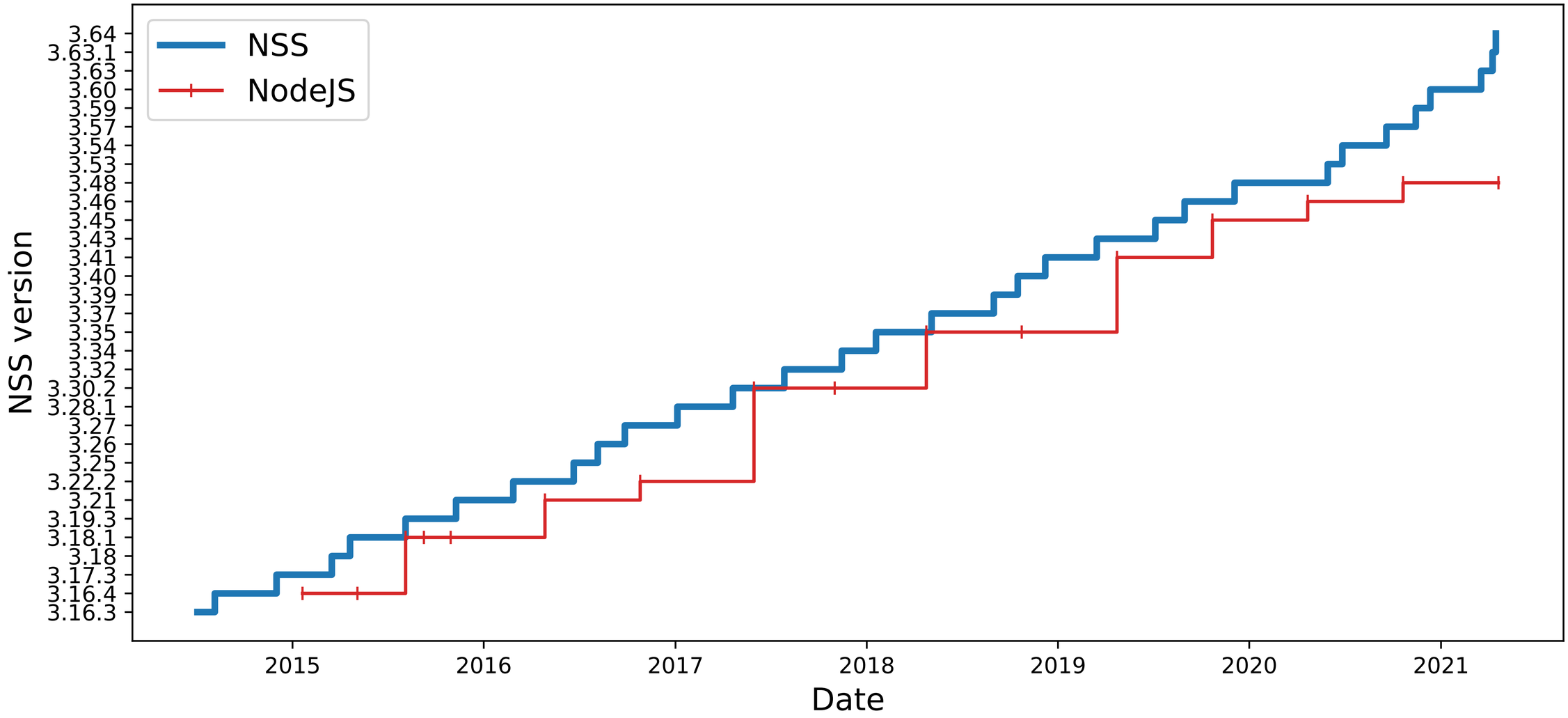

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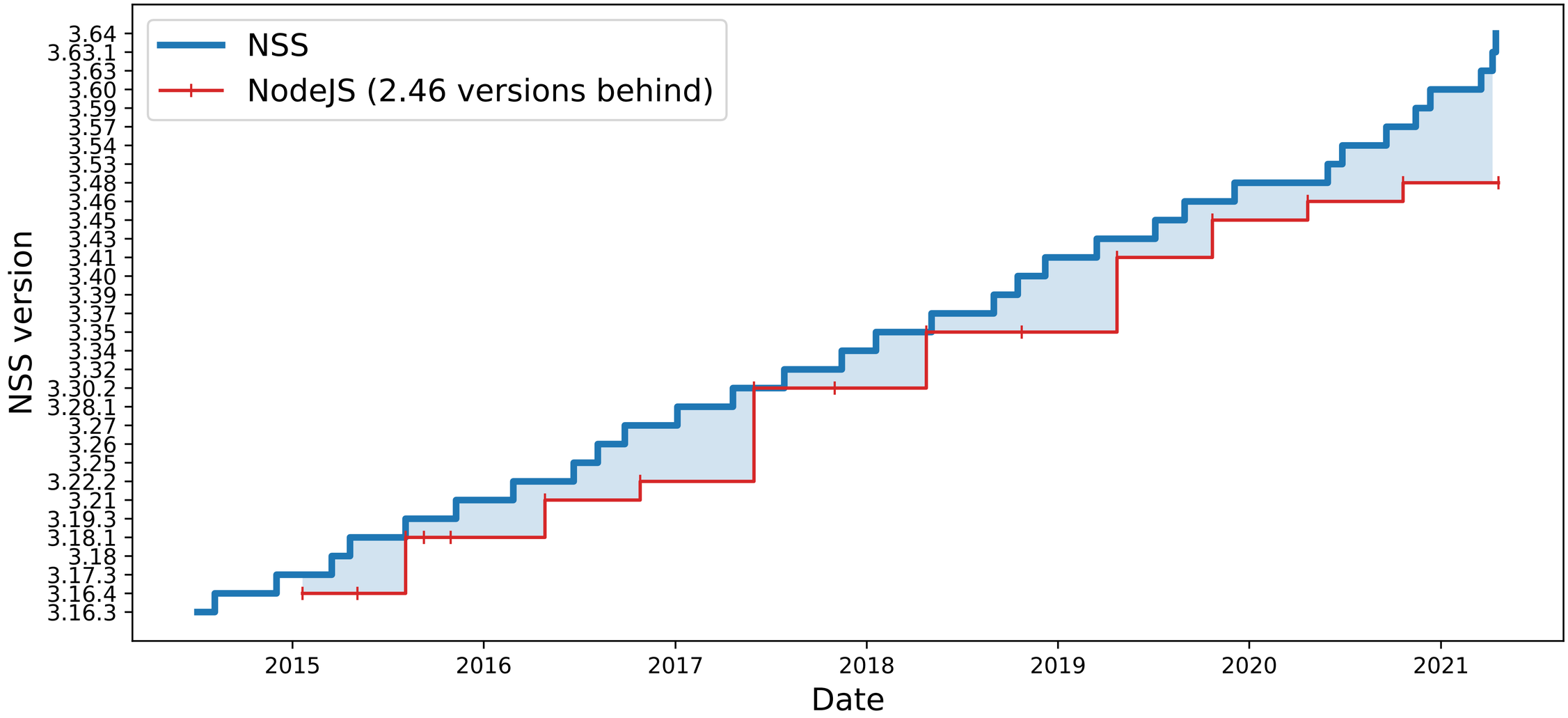

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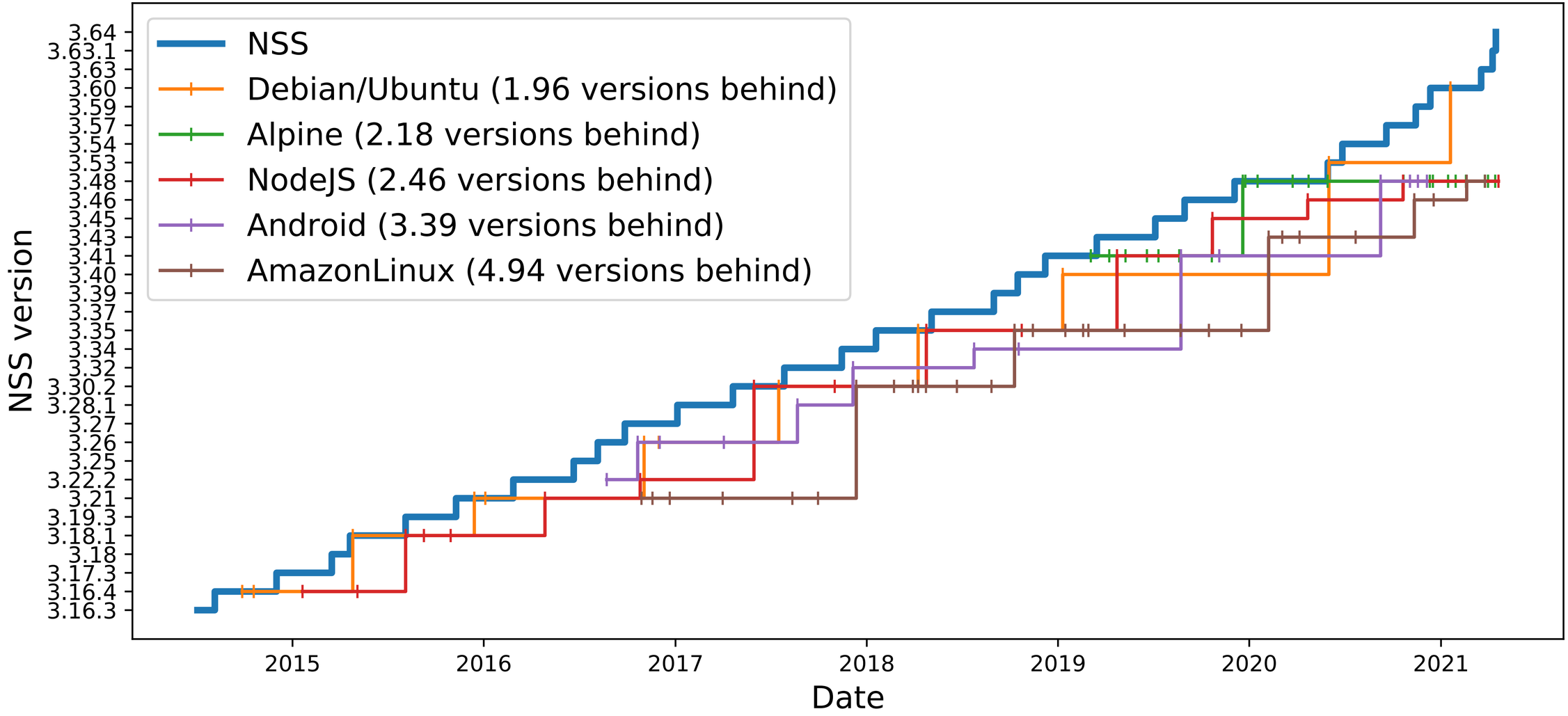

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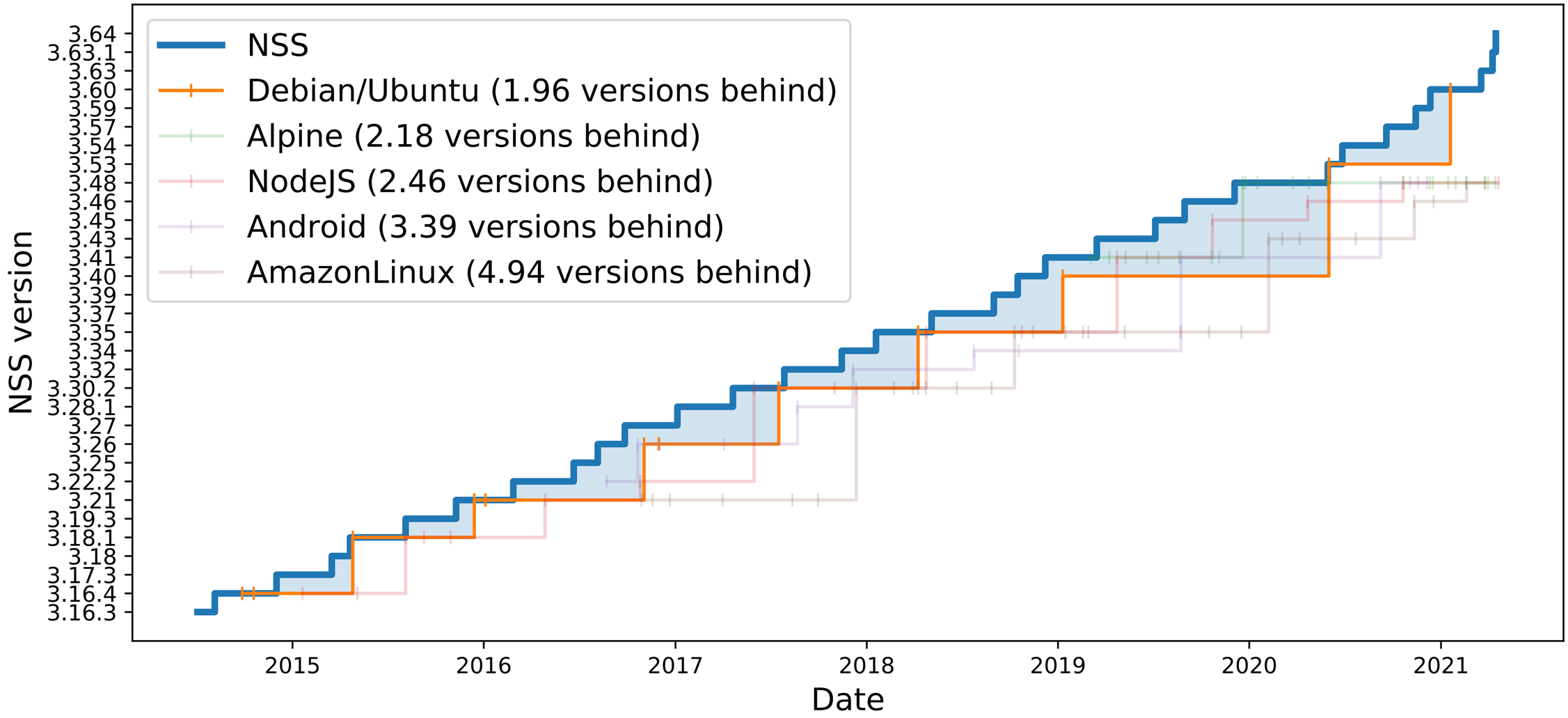

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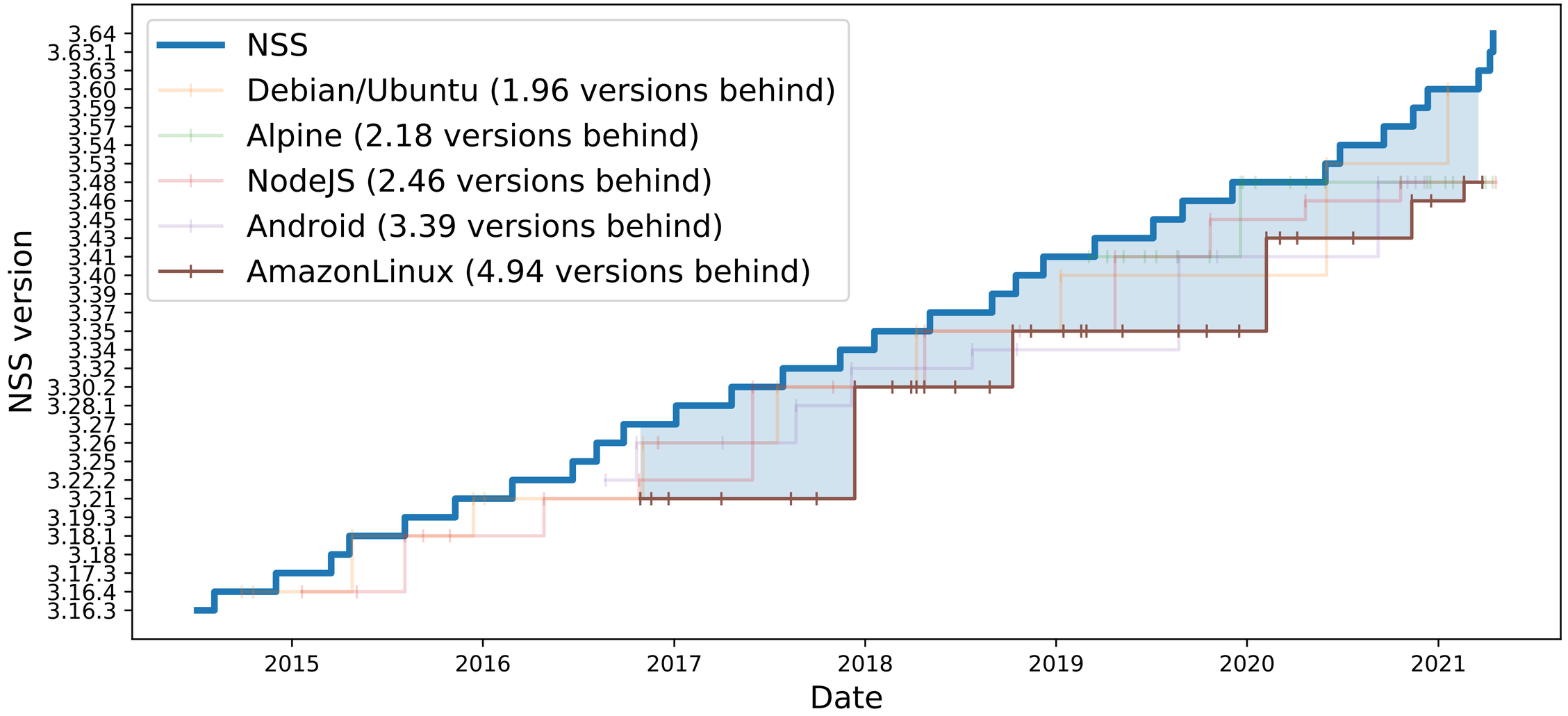
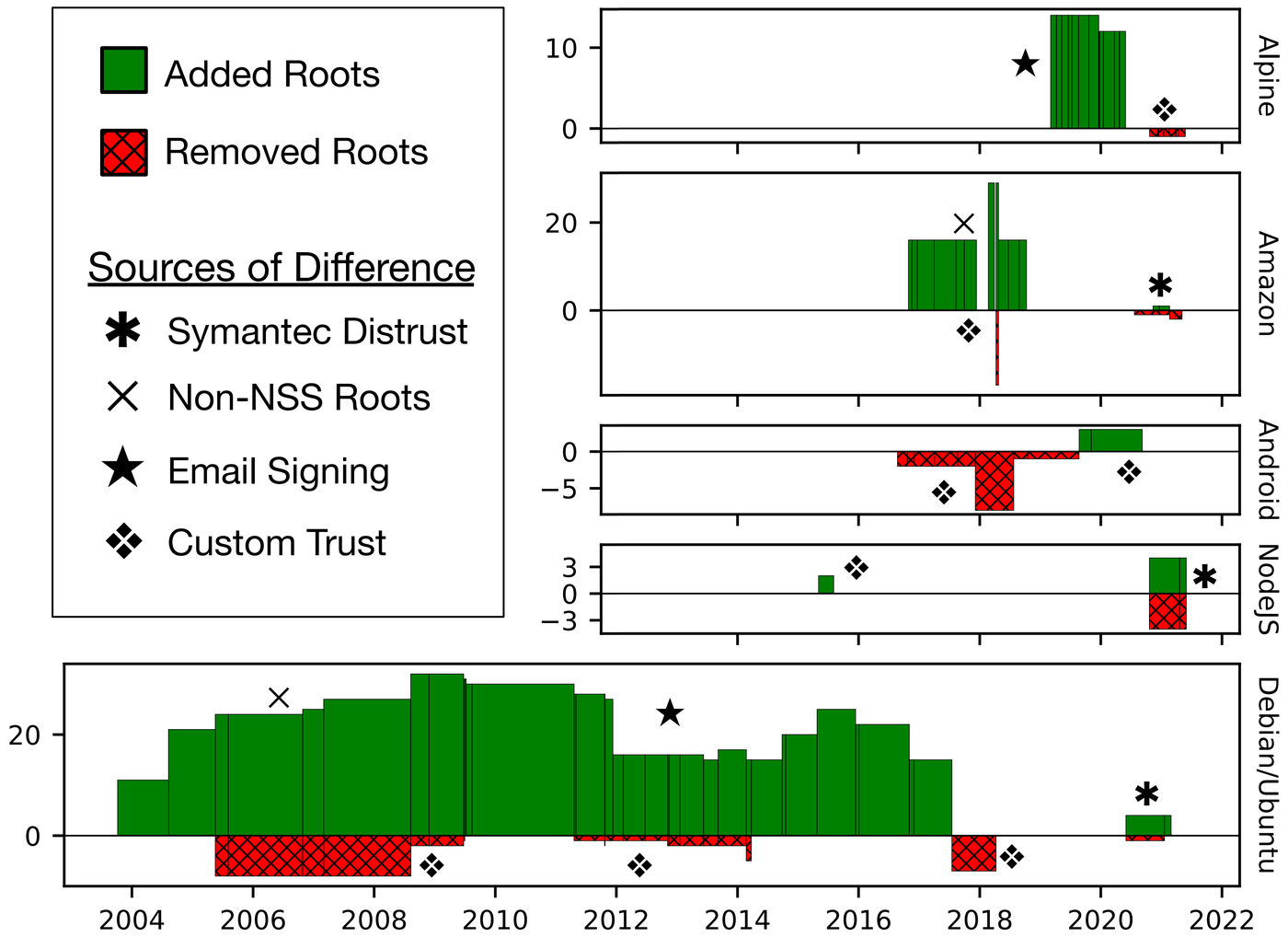


Trust deviations



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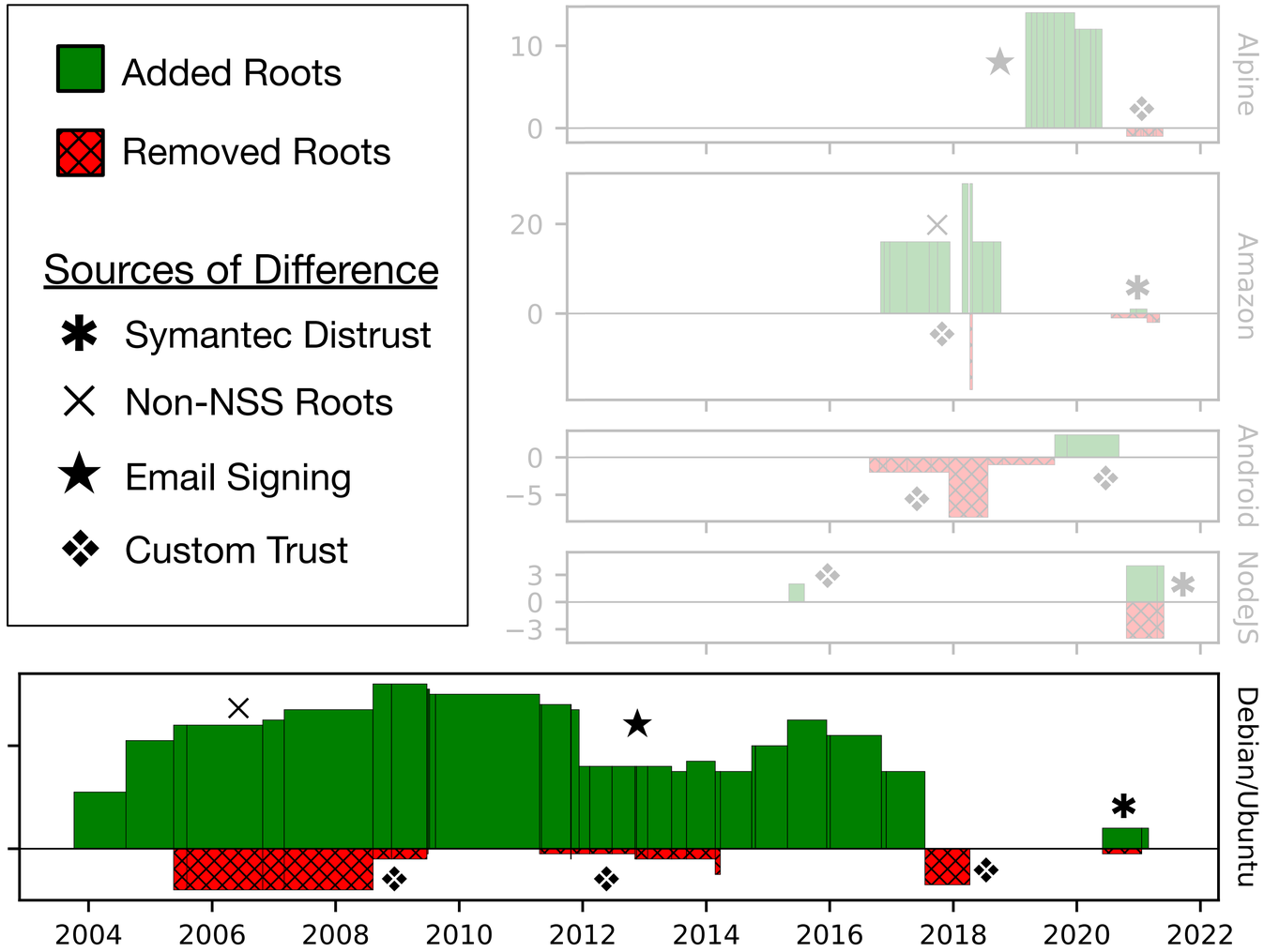

Trust purpose conflation: trusting non-TLS certificates

Partial trust incapability: Symantec distrust dilemma

Non-NSS trusted CAs: questionable trust

App. developer confusion: trusting CAs for code signing, timestamping

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Apple, Microsoft run major root programs; all other root providers originate from Mozilla's NSS root program.

NSS derivatives copy poorly: delayed updates, questionable bespoke trust, incompatible trust scope.

Future TLS applications can avoid the rough edges of existing TLS root trust and adopt more modern root store practices.

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