

Description

Client-Side Inclusion: Faster Access to Dynamic Web Content

Client-Side Inclusion (CSI) is the technology developed at AT&T Research, which allows dynamic Web page assembly from individual fragments at the Web browser. By reusing cached copies of unchanged fragments, CSI reduces the amount of data sent from the Web site to the browser and thereby lowers the download time of the page, especially for narrowband clients.

CSI uses an open mark-up language for content fragmentation that was previously proposed by content delivery networks (CDN) to reduce bandwidth consumption between origin servers and CDN's edge servers. This language, called ESI, for Edge-Side Includes, allows content providers to split their Web pages into fragments and specify how these fragments must be assembled into final documents. Each fragment can be retrieved independently by a CDN's edge server and have its own caching properties, such as expiration time. Since many web pages have a mixture of dynamic content (like stock quotes) and static content (like a page template), this design facilitates caching of unchanged fragments at the edge server and helps reduce the congestion in the network as well as the processing overhead at origin servers.

Because ESI assumed page assembly at edge servers, browsers had to download entire Web pages as usual. Thus, ESI did not affect the amount of traffic transferred over the link between the browser and the Internet, or the *last mile* as it is often called. At the same time, numerous studies showed that it is the last mile that determines the download time and hence the browsing experience of narrowband users.

By moving page assembly from edge servers to browsers, CSI pushes bandwidth savings over to the last mile. Hence, this technique not only optimizes the communication between edge servers and the origin server (as ESI) but also reduces the response time experienced by narrowband users. Additional important benefits of CSI, as compared to ESI, include the following:

1. Unlike ESI, which stipulates the usage of a CDN by the content provider, CSI is oblivious to whether or not the content provider uses CDN services. In particular, it can be offered as a value-added service of a hosting service to customers who may not wish to subscribe to a CDN.
2. For content providers who do use a CDN, CSI reduces their CDN costs by reducing the amount of content that browsers download from the edge servers. These savings are in addition to any reduction in origin server bandwidth costs provided by ESI.

Our implementation of CSI requires no modification or reconfiguration of browsers. Finally, because it supports full ESI 1.0 specification (with the exception of an optional inlining feature), Web sites that currently use ESI can start benefiting from CSI without changing their content.