

Network Working Group  
Internet-Draft  
Expires: June 23, 2003

L. Amini  
IBM Research  
S. Thomas  
TransNexus, Inc  
O. Spatscheck  
AT&T Labs  
December 2002

Distribution Requirements for Content Internetworking  
draft-ietf-cdi-distribution-reqs-01

Status of this Memo

This document is an Internet-Draft and is in full conformance with all provisions of [Section 10 of RFC2026](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/lid-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on June 23, 2003.

Copyright Notice

Copyright (C) The Internet Society (2001). All Rights Reserved.

Abstract

This document specifies requirements for interconnecting, or peering, the distribution systems of Content Networks (CN). Distribution internetworking requires advertising the capabilities of a CN offering distribution services, moving content from one CN to another, and signaling requirements for consistent storage and delivery of content. This document does not address requirements for directing user agents to distributed content, nor for aggregating access information for distributed content.

## 1. Introduction

Content Internetworking (CI) assumes an architecture wherein the resources of multiple CNs are combined so as to achieve a larger scale or reach than any of the component CNs could individually [3]. A Content Distribution Network (CDN) is an example of a CN.

At the core of CI are three principal architectural elements. These elements are Request Routing, the Distribution and the Accounting. The focus of this document, the Internetworking Distribution Systems, is responsible for moving content from one Distribution CN to another Distribution CN. Note that the original content provider is considered a degenerate case of a Distribution CN.

In any Distribution Internetworking arrangement, the relationships between Distribution CNs can always be decomposed into one or more pairs of CNs. Each CN pair comprises one CN which has, or has access to, content, and another CN which has, or has access to, systems capable of providing distribution and/or delivery functions for content. The former CN is referred to as the Content Source, while the latter is referred to as the Content Destination.

This document describes the overall architectural structure and building blocks of the internetworked Distribution Systems. It also defines the protocol requirements for interconnecting two or more Distribution CNs via their respective Content Internetworking Gateways (CIG). Specifically, it defines the requirements for:

Distribution Advertising: announcing the distribution capabilities of a Content Destination to potential Content Sources.

Content Signaling: communicating content meta-data to enable consistent storage and delivery of content to user agents.

Content Replication: moving content from a Content Source to a Content Destination.

Although this document does not specifically address requirements for communicating within a CN, it is plausible that protocols developed to meet inter-CN requirements may also be well-suited for intra-CN communications.

Requirements for the remaining CI architectural elements, the Request Routing System, which is responsible for directing user agents to the distributed content, and the Accounting System, which is responsible for aggregating information related to the access of distributed content, are detailed in [6], [7].

### [1.1](#) Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC-2119](#) [2].

All other terms in ALL CAPS, except those qualified with explicit citations, are defined in [8].

### [1.2](#) Change Log

1. Fixed terminology to comply with updated Models doc.
2. Intro: fixed reach or scale so not synonyms
3. [Section 1](#): clarified definition for Content Signaling
4. [Section 2](#): clarified that fig 1 is a logical view, need not have this strictly hierarchical relationship.
5. [Section 2.1](#)-2.2: deleted these sections, feedback indicated they confused more than clarified; material is adequately covered in Models doc.
6. [Section 3](#): change Use-initiated to surrogate initiated.
7. [Section 3](#) (para 2): cig is not necessarily a box, could be functionality (protocol conformance) implemented in multiple boxes.
8. [Section 4.1](#): clarified content signalling example.
9. [Section 4.3](#): clarified common base replication vs. content type specific replication

10. [Section 4.4](#): fixed "extensible model..." wording
11. [Section 5.1](#): clarified that content pull for delivery services preparation is optional.
12. [Section 5.3](#) 3-4: modified, added request for feedback
13. [Section 5.3.5](#): clarified advertisements as optional
14. [Section 5.4](#): dropped requirement for sending data with content signal.
15. [Section 5.4](#) 6: dropped part about source encryption -- if the object is encrypted at source and not decrypted until it

reaches the client, then it is just a (downloadable) blob as far as the dist system is concerned.

16. [Section 5.5](#) 8: dropped subscription fee and next hop.
17. [Section 5.5](#) 8: changed content id to content set id.
18. [Section 5.5](#): added information on relationship to WEBI/RUP.



## Figure 1: Distribution System Interworking

In each case, one of the parties in the communications has the role of Content Destination, while the other party is the Content Source. Note that a particular CN's role may change, depending on the party with whom it is communicating. CN B, for example, is a Content Source when communicating with CN A, but a Content Destination when communicating with CN C.

Note that a Content Destination which peers directly with the Content ORIGIN, will interface with the ORIGIN just as it interfaces with any other Content Source.

Although Figure 1 provides an example of multiple CNs peered in series, a Distribution CN may serve as the Content Source for multiple Content Destinations. Likewise, a Distribution CN may serve as the Content Destination for multiple Content Sources.

Additionally, it is possible for the internetworking relationship between a single Source-Destination pair to be reciprocal for different content sets. That is, CN A may request distribution services from CN B for Content Set A, while CN B requests distribution services from CN A for Content Set B.

Further, note that Figure 1 is a logical view of the internetworking relationship between several Content Source-Destination pairs; actual communications are not restricted to this pair-wise

hierarchy. For example, CDN D may specify a single authoritative distribution channel from which any distributing CN must retrieve the CONTENT.

### [3.](#) Replication Models

Replication of content may take place using a push model, or a pull model, or a combination of both.

- o SURROGATE-initiated replication of CONTENT, where a SURROGATE retrieves CONTENT based on a cache miss or on a prefetching

policy specified at the SURROGATE, represents the pull model. This is the model currently used by caching proxies.

- o ORIGIN-initiated replication of CONTENT to SURROGATES represents the push model. This model is used to preposition CONTENT in anticipation of demand.

Replication, when between the administrative domains of different Distribution CNs must adhere to the CI protocol for content replication. Replication within a single Distribution CN is an intra-CN communication and therefore, need not adhere to CI protocols. Further, the replication model used within a single Distribution CN need not be the same as the model used to replicate CONTENT between CNs.

For both ORIGIN- and SURROGATE- initiated replication, the Content Source may use replication mechanisms beyond a simple transfer. For example, it may be desirable to have the Content Destination join a multicast channel on which a set of content is pushed to all SURROGATES.

Another example is for CONTINUOUS MEDIA. In the case of live broadcasts, the data need not be cached on the SURROGATES. Instead, replication takes the form of "splitting" the live stream at various points in the network. Splitting is also referred to as application layer multicast.

Replication of CONTINUOUS MEDIA streams which are not live, and therefore may be stored on SURROGATES, also benefits from mechanisms beyond in-line replication. For example, CONTINUOUS MEDIA is often delivered to CLIENTS over an unreliable channel. However, a CN distributing this content to many CLIENTS should work with a full replica. Existing proprietary replication protocols enable distribution of CONTINUOUS MEDIA objects in which a full or partial replica can be propagated, the data may be encrypted and/or authenticated, and the SURROGATE can support CONTINUOUS MEDIA-related services such as random access and stream insertion/splicing.

It may be desirable to replicate content to a Distribution CN which has no internal SURROGATES. For example, a Distribution CN may have servers at key exchange points within the network which only serve



content to other distribution systems, and peer with other CNs which provide SURROGATES which deliver content to CLIENTS.

## [4. Distribution Internetworking Requirements](#)

This section details general requirements for exchange of inter-domain distribution information.

### [4.1 General Requirements](#)

The goal of the Distribution Internetworking is to interconnect the Distribution Systems of multiple CNs. The intent of this interconnection is to effectively position content for fast, reliable access by CLIENTs. Generally this is accomplished by replicating content on SURROGATEs. While the communications path from ORIGIN to CLIENTs may traverse a number of links, some within a Distribution CN and some between Distribution CNs, Distribution Internetworking is concerned only with those communications between Distribution CNs.

The three main components of Distribution Internetworking are advertising, replication, and signaling.

**Advertising:** Distribution CNs MAY advertise their capabilities to potential Content Source CNs.

**Replication:** Distribution CNs MUST be able to move content from a Content Source to a Content Destination.

**Content signaling:** Distribution CNs MUST be able to propagate content meta-data. This meta-data includes information such as the immediate invalidation of content or a change in the source or distribution method of content.

Note that these requirements do not necessarily translate directly into three distinct Distribution Internetworking protocols.

### [4.2 Advertising Requirements](#)

The following list specifies requirements to enable advertising of distribution capabilities.

1. A common protocol for the Advertisement of distribution capabilities.
2. A common format for the actual distribution capabilities

Advertisements in the protocol.

3. Security mechanisms.

Amini, et. al.

Expires June 23, 2003

[Page 9]

---

Internet-Draft

CI Distribution Requirements

December 2002

#### [4.3](#) Replication Requirements

The following list specifies requirements to enable content replication.

1. A common base protocol for the replication of content.
2. This common base protocol should specify:
  - \* a common format for the actual content data in the protocol.
  - \* A common format for the content meta-data in the protocol.
3. Alternate content-specific protocols for the replication of content should be enabled. The replication protocol for a particular content set is specified via content signaling.
4. Scalable distribution of the content.
5. Security mechanisms.

#### [4.4](#) Content Signaling Requirements

The following list specifies requirements to enable content signaling.

1. A common protocol for signaling content meta-data.
2. An extensible format for communicating content metadata. Minimally, support is required for "add," "withdraw," and "expiration time update."
3. Scalable distribution of signals on a scale to enable Internet-wide peering.
4. Security mechanisms.

## [5.](#) Distribution Internetworking Protocol Requirements

This section defines protocol requirements for each of the advertising, replication and content signaling components of Distribution Internetworking. Note that these requirements do not necessarily translate directly into either one converged or three distinct Distribution Internetworking protocols.

### [5.1](#) Overview of Distribution Internetworking Flow

In a Distribution Internetworking arrangement, the following sequence of events is expected:

1. A Content Source may receive distribution capabilities advertisements from one or more Content Destinations. A Content Source may or may not require receipt of distribution capabilities advertisements prior to requesting services. For example, a Content Source may request services based on a contractual agreement negotiated off-line.
2. The Content Source will make a decision to request content distribution services from a Content Destination.
3. The Content Source will send a content signal requesting distribution services.
4. The Content Destination will accept or reject the request; no partial acceptance or negotiation is defined.

- \* If the request is rejected, the error code SHOULD provide enough information for the Content Source to determine if it should send a request with modified service requirements.
- \* If the request is accepted, the Content Destination will prepare for distribution services. Generally, this preparation will entail:
  - + optionally retrieving a copy of the object(s),
  - + joining the content update channel (if any), and
  - + preparing to provide access information to the Accounting System
- \* Each of the above steps are according to the Content Source's specification, and to the Content Destination's policies and configuration.

5. Once the Content Destination is prepared, it will notify the

Request Routing System of the content's availability.

6. The Content Destination will terminate service on first occurrence of either:

- \* the time frame specified in the Content Source's request for distribution services expires or
- \* a content signal requesting withdrawal of the content is received.

## [5.2](#) General Distribution Internetworking Protocol Requirements

Protocols must be scalable, i.e., support Distribution Internetworking on an Internet-wide scale.

Protocols must prevent looping of advertisements, replication and content signaling.

Protocols must support the ability to optionally conduct authenticated and/or encrypted exchanges.

Protocols must support the ability to optionally exchange credentials.

### [5.3](#) Advertising Protocol Requirements

1. Distribution Internetworking protocols MUST enable a Content Destination to advertise the capabilities of its distribution service in a common format. This common format for distribution service capabilities will be referred to as a Service Profile for the remainder of this draft.
2. The advertisement protocol must be extensible with the restriction that implementation-specific capabilities may be safely ignored by Content Source.
3. Distribution Internetworking protocols MUST provide low-overhead, mechanism to notify in-line elements (e.g., proxies) of CI support.
4. [ Editor's Note: prev item can be as simple as having the Content Source include a reference to its CIG so that inline systems could contact the CIG and establish an internetworking arrangement. But the feedback has been lukewarm to bad -- drop? ]
5. Distribution Advertising by a Content Destination must be optional. That is, a Content Source may not require real-time

advertisement of distribution capabilities in order to establish a Distribution Internetworking arrangement. Distribution capabilities may be communicated via Advertisements or some other agreed upon mechanism such as an off-line contract negotiated between the parties.

6. Advertised capabilities are those available to the peer, potentially based on some off-line contractual agreement, and may not necessarily reflect the total capacity of the Content Destination.
7. The protocol MUST enable a Content Destination to advertise multiple service profiles. Each service profile MUST be specifiable by a profile identifier. The profile identifier MAY encode Content Source or Content Destination specific

information, but it has local significance only (i.e., it is strictly between the Content Source and Content Destination).

8. The protocol MUST enable a Content Destination to advertise multiple services profiles to the same or different potential Content Sources.
9. A Content Destination with regional capabilities SHOULD advertise capabilities on a per region basis. A Content Destination which advertises regional capabilities MUST minimally be able to identify regions by network addresses/prefixes.
10. By default, advertisements are advisory. A Content Destination SHOULD be able to specify whether the capabilities are advisory or binding.
11. The protocol MUST provide the ability to specify distribution capabilities in terms of one or more of the following attributes:

Profile ID: Identifier for the service profile being advertised. The profile identifier is to be used by the Content Source when requesting service. This attribute is required for all advertisements. The value need not be unique across Distribution CNs, and may be used in advertisements to multiple Content Sources.

FootPrint: The areas served by the CN. Minimally, a Content Destination should support expressing footprint according to IP network addresses/prefixes.

Content Type: The type of content (e.g. static Web pages, streaming media, etc.) that the CN is able to distribute.

Capacity: The storage capacity that the CN can provide.

Bandwidth: Maximum outbound bandwidth available from the CN.

Object Bandwidth: Maximum outbound bandwidth supported for a single object.

Distribution Method: The distribution methods that the CN

supports; one or more of push, pull, and alm. "alm" refers to application layer multicast, or splitting, of CONTINUOUS MEDIA; if specified, supported protocols must also be specified.

[ Editor's Note: Specifying support for splitting requires refinement. ]

**Request Routing Type:** Type(s) of request routing supported for CI Request Routing Systems.

**Accounting System Format:** Supported protocol(s) and format(s) for sending accounting and access feedback to a specified CI Accounting System.

**Time Frame:** Time frame for which this advertisement is valid.

**Client Protocols:** Indicates the client protocols supported. Currently only HTTP and RTSP are valid. However, this field must be further qualified than just the transport or signalling protocol. The protocol must clearly define a level of support implicated by a given Client Protocol value.

**Distribution Fee:** Indicates the fee charged for distribution services. The value may be expressed in Mbps (megabits/second) or in MB (megabytes of storage).

**Advertisement Type:** Indicates whether the advertisement is advisory or binding. By default, all advertisements are advisory.

**Private Extensions:** Additional metrics that the communicating parties may agree to use, but are not part of the IETF standard. Extensions must be defined such that if not understood by the Content Source, they can be safely ignored.



To be provided.

#### [5.4](#) Replication Protocol Requirements

1. A common (base) replication protocol MUST be defined which is supported by all CIGs, for any content type which can be used to transport meta-data and a full replica of content data.
2. Replication MUST support the ability for a Content Source to specify a replication channel from which content may be retrieved.
  1. [ Editors Note: I am using channel as a generic term which would provide a contact point and protocol, and any additional info required to establish a connection. E.g. `wcips://invalidation.com/content_set` for signaling; will provide clarification later ]
3. Replication MUST enable specifying optionally supported, alternative replication protocols which may be better suited than the common base protocol for specific content types or configuration scenarios.
4. A Content Source SHOULD be able to specify an authoritative source for content as well as distribution points.
5. The protocol MUST enable replication that is secured (encrypted) across the communications channel.

##### [5.4.1](#) Replication Examples

To be provided.

#### [5.5](#) Content Signaling Protocol Requirements

1. A Content Source MUST be able to request distribution services for one or more content objects.
2. A Content Destination MUST explicitly accept or reject a request for distribution services.
3. A Content Source MUST be able to withdraw (cancel) a request for content services for one or multiple content objects.
4. Rejected requests for distribution services MUST include error codes. Partial rejections or negotiations are not supported. A Content Source may follow a rejection with a request for

---

distribution services under alternate service requirements.

5. A Content Source **MUST** be able to signal consistency meta-data. Minimally, Content Sources **SHOULD** support weak consistency mechanisms. Content Sources **MAY** support mechanisms for strong consistency.
6. Content signaling **SHOULD** include mechanisms to aggregate content information.
7. Content Signaling **SHOULD** be decoupled from the content **ORIGIN**. I.e., a Content Source should be able to specify a content signaling channel.
8. The following attributes are defined for content signals:

**Content Set ID:** A unique identifier for this specific content set, so that future references (e.g. to modify the content or to withdraw it from distribution) may be resolved. This value can also be used to avoid loops. The Content Set ID **MUST** be global and unique, i.e., a given content set **MUST** have the same ID across all Distribution Systems, and this ID **MUST** be unique across *\*all\** Distribution Systems.

**URI:** The uniform resource identifier for the content. It identifies how **CLIENTS** will request delivery services from the Distribution **CN**. This attr