Media Capture and Streams

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Abstract

This document defines a set of JavaScript APIs that allow local media, including audio and video, to be requested from a platform.

Status of This Document

This section describes the status of this document at the time of its publication. Other documents may supersede this document. A list of current W3C publications and the latest revision of this technical report can be found in the W3C technical reports index at https://www.w3.org/TR/.

This document is not complete. It is subject to major changes and, while early experimentations are encouraged, it is therefore not intended for implementation. The API is based on preliminary work done in the WHATWG.

This document was published by the Web Real-Time Communications Working Group as an Editor's Draft.

GitHub Issues are preferred for discussion of this specification. Alternatively, you can send comments to our mailing list. Please send them to public-webrtc@w3.org (archives).

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This document is governed by the 15 September 2020 W3C Process Document.

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1. Introduction §

This section is non-normative.

This document defines APIs for requesting access to local multimedia devices, such as microphones or video cameras.

This document also defines the MediaStream API, which provides the means to control where multimedia stream data is consumed, and provides some control over the devices that produce the media. It also exposes information about devices able to capture and render media.

2. Conformance §

As well as sections marked as non-normative, all authoring guidelines, diagrams, examples, and notes in this specification are non-normative. Everything else in this specification is normative.

The key words *MAY*, *MUST*, *MUST NOT*, *NOT REQUIRED*, and *SHOULD* in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

This specification defines conformance criteria that apply to a single product: the **User Agent** that implements the interfaces that it contains.

Conformance requirements phrased as algorithms or specific steps may be implemented in any manner, so long as the end result is equivalent. (In particular, the algorithms defined in this specification are intended to be easy to follow, and not intended to be performant.)

Implementations that use ECMAScript [ECMA-262] to implement the APIs defined in this specification must implement them in a manner consistent with the ECMAScript Bindings defined in the Web IDL specification [WEBIDL], as this specification uses that specification and terminology.

3. Terminology §

HTML Terms:

The `EventHandler` interface represents a callback used for event handlers as defined in [HTML].

The concept queue a task is defined in [HTML] and fire an event is defined in [DOM].

The terms event handlers and responsible document are defined in [HTML].

The term relevant settings object is defined in [HTML].

The term allowed to use is defined in [HTML].

The terms **fulfilled**, **rejected** and **resolved** used in the context of Promises are defined in [ECMA-262].

DOM

The terms `Event`, `EventInit` and `EventTarget` are defined in the [DOM] specification.

`DOMException`
: The term `DOMException` is defined in [WEBIDL]

source
: A source is the "thing" providing the source of a media stream track. The source is the broadcaster of the media itself. A source can be a physical webcam, microphone, local video or audio file from the user's hard drive, network resource, or static image. Note that this document describes the use of microphone and camera type sources only, the use of other source types is described in other documents.

An application that has no prior authorization regarding sources is only given the number of available sources, their type and any relationship to other devices. Additional information about sources can become available when applications are authorized to use a source (see § 9.2.1 Access control model).

Sources **do not** have constraints — tracks have constraints. When a source is connected to a track, it must produce media that conforms to the constraints present on that track, to that track. Multiple tracks can be attached to the same source. User Agent processing, such as downsampling, *MAY* be used to ensure that all tracks have appropriate media.

Sources have constrainable properties which have capabilities and settings exposed on tracks. While the constrainable properties are "owned" by the source, sources *MAY* be able to accomodate different demands at once. For this reason, capabilities are common to any (multiple) tracks that happen to be using the same source, whereas settings *MAY* differ per track (e.g., if two different track objects bound to the same source query capability and settings information, they will get back the same capabilities, but may get different settings that are tailored to satisfy their individual constraints).

***Setting* (Source Setting)**
: A setting refers to the immediate, current value of the source's constrainable properties. Settings are always read-only.

A source conditions may dynamically change, such as when a camera switches to a lower frame rate due to low light conditions. In these cases the tracks related to the affected source might not satisfy the set constraints any longer. The platform *SHOULD* try to minimize such excursions as far as possible, but will continue to deliver media even when a temporary or permanent condition exists that prevents satisfying the constraints.

Although settings are a property of the source, they are only exposed to the application through the tracks attached to the source. This is exposed via the `ConstrainablePattern` interface.

Capability
: For each constrainable property, there is a capability that describes whether it is supported by the

source and if so, the range of supported values. As with settings, capabilities are exposed to the application via the `ConstrainablePattern` interface.

The values of the supported capabilities must be normalized to the ranges and enumerated types defined in this specification.

A `getCapabilities()` call on a track returns the same underlying per-source capabilities for all tracks connected to the source.

Source capabilities are effectively constant. Applications should be able to depend on a specific source having the same capabilities for any browsing session.

This API is intentionally simplified. Capabilities are not capable of describing interactions between different values. For instance, it is not possible to accurately describe the capabilities of a camera that can produce a high resolution video stream at a low frame rate and lower resolutions at a higher frame rate. Capabilities describe the complete range of each value. Interactions between constraints are exposed by attempting to apply constraints.

***Constraint*s**

Constraints provide a general control surface that allows applications to both select an appropriate source for a track and, once selected, to influence how a source operates.

Constraints limit the range of operating modes that a source can use when providing media for a track. Without provided track constraints, implementations are free to select a source's settings from the full ranges of its supported capabilities. Implementations may also adjust source settings at any time within the bounds imposed by all applied constraints.

`getUserMedia()` uses constraints to help select an appropriate source for a track and configure it. Additionally, the `ConstrainablePattern` interface on tracks includes an API for dynamically changing the track's constraints at any later time.

A track will not be connected to a source using `getUserMedia()` if its initial constraints cannot be satisfied. However, the ability to meet the constraints on a track can change over time, and constraints can be changed. If circumstances change such that constraints cannot be met, the `ConstrainablePattern` interface defines an appropriate error to inform the application. § 5. The model: sources, sinks, constraints, and settings explains how constraints interact in more detail.

For each constrainable property, a constraint exists whose name corresponds with the relevant source setting name and capability name.

A constraint falls into one of three groups, depending on its place in the constraints structure. The groups are:

- **required constraints** are all non-advanced constraints that are required.
- **optional basic constraints** are the remaining non-advanced constraints.
- **advanced constraints** are all constraints specified using the `advanced` keyword.

In general, User Agents will have more flexibility to optimize the media streaming experience the fewer constraints are applied, so application authors are strongly encouraged to use required constraints sparingly.

Permissions
The terms **reading current permission state** and request permission to use are defined in [permissions].

4. MediaStream API §

4.1 Introduction §

The two main components in the MediaStream API are the **`MediaStreamTrack`** and **`MediaStream`** interfaces. The `MediaStreamTrack` object represents media of a single type that originates from one media source in the User Agent, e.g. video produced by a web camera. A `MediaStream` is used to group several `MediaStreamTrack` objects into one unit that can be recorded or rendered in a media element.

Each `MediaStream` can contain zero or more `MediaStreamTrack` objects. All tracks in a `MediaStream` are intended to be synchronized when rendered. This is not a hard requirement, since it might not be possible to synchronize tracks from sources that have different clocks. Different `MediaStream` objects do not need to be synchronized.

NOTE

While the intent is to synchronize tracks, it could be better in some circumstances to permit tracks to lose synchronization. In particular, when tracks are remotely sourced and real-time [WEBRTC], it can be better to allow loss of synchronization than to accumulate delays or risk glitches and other artifacts. Implementations are expected to understand the implications of choices regarding synchronization of playback and the effect that these have on user perception.

A single `MediaStreamTrack` can represent multi-channel content, such as stereo or 5.1 audio or stereoscopic video, where the channels have a well defined relationship to each other. Information about channels might be exposed through other APIs, such as [WEBAUDIO], but this specification provides no direct access to channels.

A `MediaStream` object has an input and an output that represent the combined input and output of all the object's tracks. The output of the `MediaStream` controls how the object is rendered, e.g., what is saved if the object is recorded to a file or what is displayed if the object is used in a `video` element. A single `MediaStream` object can be attached to multiple different outputs at the same time.

A new `MediaStream` object can be created from existing media streams or tracks using the `MediaStream()` constructor. The constructor argument can either be an existing `MediaStream` object, in which case all the tracks of the given stream are added to the new `MediaStream` object, or an array of `MediaStreamTrack` objects. The latter form makes it possible to compose a stream from different source streams.

Both `MediaStream` and `MediaStreamTrack` objects can be cloned. A cloned `MediaStream` contains clones of all member tracks from the original stream. A cloned `MediaStreamTrack` has a set of constraints that is independent of the instance it is cloned from, which allows media from the same source to have different constraints applied for different consumers. The `MediaStream` object is also used in contexts outside `getUserMedia`, such as [WEBRTC].

4.2 `MediaStream` §

The MediaStream **`constructor`** composes a new stream out of existing tracks. It takes an optional argument of type `MediaStream` or an array of `MediaStreamTrack` objects. When the constructor is invoked, the User Agent must run the following steps:

1. Let *stream* be a newly constructed `MediaStream` object.
2. Initialize *stream*.`id` attribute to a newly generated value.
3. If the constructor's argument is present, run the following steps:
    1. Construct a set of tracks *tracks* based on the type of argument:
        - A `MediaStream` object:

          Let *tracks* be a set containing all the `MediaStreamTrack` objects in the `MediaStream` track set.
        - A sequence of `MediaStreamTrack` objects:

Let *tracks* be a set containing all the `MediaStreamTrack` objects in the provided sequence.

2. For each `MediaStreamTrack`, *track* , in *tracks*, run the following steps:
    1. If *track* is already in *stream*'s track set, skip *track*.
    2. Otherwise, add *track* to *stream*'s track set.

4. Return *stream*.

The tracks of a `MediaStream` are stored in a **track set**. The track set *MUST* contain the `MediaStreamTrack` objects that correspond to the tracks of the stream. The relative order of the tracks in the set is User Agent defined and the API will never put any requirements on the order. The proper way to find a specific `MediaStreamTrack` object in the set is to look it up by its `id`.

An object that reads data from the output of a `MediaStream` is referred to as a `MediaStream` **consumer**. The list of `MediaStream` consumers currently include media elements (such as `video` and `audio`) [HTML], Web Real-Time Communications (WebRTC; `RTCPeerConnection`) [WEBRTC], media recording (`MediaRecorder`) [mediastream-recording], image capture (`ImageCapture`) [image-capture], and web audio (`MediaStreamAudioSourceNode`) [WEBAUDIO].

NOTE

`MediaStream` consumers must be able to handle tracks being added and removed. This behavior is specified per consumer.

A `MediaStream` object is said to be **active** when it has at least one `MediaStreamTrack` that has not ended. A `MediaStream` that does not have any tracks or only has tracks that are ended is **inactive**.

A `MediaStream` object is said to be **audible** when it has at least one `MediaStreamTrack` whose `kind` is `"audio"` that has not ended. A `MediaStream` that does not have any audio tracks or only has audio tracks that are ended is **inaudible**.

The User Agent may update a `MediaStream`'s track set in response to, for example, an external event. This specification does not specify any such cases, but other specifications using the MediaStream API may. One such example is the WebRTC 1.0 [WEBRTC] specification where the track set of a `MediaStream`, received from another peer, can be updated as a result of changes to the media session.

To **add a track** *track* to a `MediaStream` *stream*, the User Agent *MUST* run the following steps:

1. If *track* is already in *stream's* track set, then abort these steps.

2. Add *track* to *stream*'s track set.
3. Fire a track event named `addtrack` with *track* at *stream*.

To **remove a track** *track* from a `MediaStream` *stream*, the User Agent *MUST* run the following steps:

1. If *track* is not in *stream's* track set, then abort these steps.
2. Remove *track* from *stream*'s track set.
3. Fire a track event named `removetrack` with *track* at *stream*.

WebIDL

```
[Exposed=Window]
interface MediaStream : EventTarget {
  constructor();
  constructor(MediaStream stream);
  constructor(sequence<MediaStreamTrack> tracks);
  readonly attribute DOMString id;
  sequence<MediaStreamTrack> getAudioTracks();
  sequence<MediaStreamTrack> getVideoTracks();
  sequence<MediaStreamTrack> getTracks();
  MediaStreamTrack? getTrackById(DOMString trackId);
  undefined addTrack(MediaStreamTrack track);
  undefined removeTrack(MediaStreamTrack track);
  MediaStream clone();
  readonly attribute boolean active;
  attribute EventHandler onaddtrack;
  attribute EventHandler onremovetrack;
};
```

Constructors §

`MediaStream`

See the MediaStream constructor algorithm

No parameters.

`MediaStream`

See the MediaStream constructor algorithm

`MediaStream`

See the MediaStream constructor algorithm

Attributes §

`id` of type `DOMString`, readonly

When a `MediaStream` is created, the User Agent *MUST* generate an identifier string, and *MUST* initialize the object's `id` attribute to that string, unless the object is created as part of a special purpose algorithm that specifies how the stream id must be initialized. A good practice is to use a UUID [rfc4122], which is 36 characters long in its canonical form. To avoid fingerprinting, implementations *SHOULD* use the forms in section 4.4 or 4.5 of RFC 4122 when generating UUIDs.

The `id` attribute *MUST* return the value to which it was initialized when the object was created.

***`active`* of type `boolean`, readonly**

The `active` attribute *MUST* return `true` if this `MediaStream` is active and `false` otherwise.

***`onaddtrack`* of type `EventHandler`**

The event type of this event handler is `addtrack`.

***`onremovetrack`* of type `EventHandler`**

The event type of this event handler is `removetrack`.

Methods §

`getAudioTracks`

Returns a sequence of `MediaStreamTrack` objects representing the audio tracks in this stream.

The `getAudioTracks` method *MUST* return a sequence that represents a snapshot of all the `MediaStreamTrack` objects in this stream's track set whose `kind` is equal to `"audio"`. The conversion from the track set to the sequence is User Agent defined and the order does not have to be stable between calls.

`getVideoTracks`

Returns a sequence of `MediaStreamTrack` objects representing the video tracks in this stream.

The `getVideoTracks` method *MUST* return a sequence that represents a snapshot of all the `MediaStreamTrack` objects in this stream's track set whose `kind` is equal to `"video"`. The conversion from the track set to the sequence is User Agent defined and the order does not have to be stable between calls.

`getTracks`

Returns a sequence of `MediaStreamTrack` objects representing all the tracks in this stream.

The `getTracks` method *MUST* return a sequence that represents a snapshot of all the `MediaStreamTrack` objects in this stream's track set, regardless of `kind`. The conversion from the track set to the sequence is User Agent defined and the order does not have to be stable between calls.

`getTrackById`

The `getTrackById` method *MUST* return either a `MediaStreamTrack` object from this stream's track set whose `id` is equal to *trackId*, or `null`, if no such track exists.

`addTrack`

Adds the given `MediaStreamTrack` to this `MediaStream`.

When the `addTrack` method is invoked, the User Agent *MUST* run the following steps:

1. Let *track* be the methods argument and *stream* the `MediaStream` object on which the method was called.
2. If *track* is already in *stream*'s track set, then abort these steps.
3. Add *track* to *stream*'s track set.

`removeTrack`

Removes the given `MediaStreamTrack` object from this `MediaStream`.

When the `removeTrack` method is invoked, the User Agent *MUST* run the following steps:

1. Let *track* be the methods argument and *stream* the `MediaStream` object on which the method was called.
2. If *track* is not in *stream's* track set, then abort these steps.
3. Remove *track* from *stream*'s track set.

`clone`

Clones the given `MediaStream` and all its tracks.

When the `clone()` method is invoked, the User Agent *MUST* run the following steps:

1. Let *streamClone* be a newly constructed `MediaStream` object.
2. Initialize *streamClone*.`MediaStream`.`id` to a newly generated value.

3. Clone each track in this `MediaStream` object and add the result to *streamClone*'s track set.
4. Return *streamClone*.

4.3 `MediaStreamTrack` §

A `MediaStreamTrack` object represents a media source in the User Agent. An example source is a device connected to the User Agent. Other specifications may define sources for `MediaStreamTrack` that override the behavior specified here. Several `MediaStreamTrack` objects can represent the same media source, e.g., when the user chooses the same camera in the UI shown by two consecutive calls to `getUserMedia()`.

The data from a `MediaStreamTrack` object does not necessarily have a canonical binary form; for example, it could just be "the video currently coming from the user's video camera". This allows User Agents to manipulate media in whatever fashion is most suitable on the user's platform.

A script can indicate that a `MediaStreamTrack` object no longer needs its source with the `stop()` method. When all tracks using a source have been stopped or ended by some other means, the source is **stopped**. If the source is a device exposed by `getUserMedia()`, then when the source is stopped, the UA *MUST* run the following steps:

1. Let *deviceId* be the device's `deviceId`.
2. Set [[devicesLiveMap]][*deviceId*] to `false`.
3. If the result of reading the current permission state of the permission associated with the device's kind and *deviceId*, is not "`granted`", then set [[devicesAccessibleMap]][*deviceId*] to `false`.

An implementation may use a per-source reference count to keep track of source usage, but the specifics are out of scope for this specification.

To **clone a track** the User Agent *MUST* run the following steps:

1. Let *track* be the `MediaStreamTrack` object to be cloned.
2. Let *trackClone* be a newly constructed `MediaStreamTrack` object.
3. Initialize *trackClone*.`id` to a newly generated value.
4. Initialize *trackClone*'s `kind`, `label`, `readyState`, and `enabled` attributes by copying the corresponding values from *track*.

5. Let *trackClone*'s underlying source be the source of *track*.

6. Set *trackClone*'s constraints to the active constrains of *track*.

7. Return *trackClone*.

4.3.1 Life-cycle and Media Flow §

Life-cycle §

A `MediaStreamTrack` has two states in its life-cycle: live and ended. A newly created `MediaStreamTrack` can be in either state depending on how it was created. For example, cloning an ended track results in a new ended track. The current state is reflected by the object's `readyState` attribute.

In the live state, the track is active and media is available for use by consumers (but may be replaced by zero-information-content if the `MediaStreamTrack` is muted or disabled, see below).

A muted or disabled `MediaStreamTrack` renders either silence (audio), black frames (video), or a zero-information-content equivalent. For example, a video element sourced by a muted or disabled `MediaStreamTrack` (contained within a `MediaStream`), is playing but the rendered content is the muted output.

If the source is a device exposed by `getUserMedia()`, then when a track becomes either muted or disabled, and this brings all tracks connected to the device to be either muted, disabled, or stopped, then the UA *MAY*, using the device's `deviceId`, *deviceId*, set [[devicesLiveMap]][*deviceId*] to `false`, provided the UA sets it back to `true` as soon as any unstopped track connected to this device becomes un-muted or enabled again.

When a "`live`", unmuted, and enabled track sourced by a device exposed by `getUserMedia()` becomes either [= track/muted or disabled, and this brings *all* tracks connected to the device (regardless of browsing context) to be either muted, disabled, or stopped, then the UA *SHOULD* relinquish the device within 3 seconds while allowing time for a reasonably-observant user to become aware of the transition. The UA *SHOULD* attempt to reacquire the device as soon as any live track sourced by the device becomes both unmuted and enabled again, provided that track's relevant settings object's responsible document has focus at that time. If the document does not have focus at that time, the UA *SHOULD* instead queue a task to mute the track, and not queue a task to unmute it until the document regains focus. If reacquiring the device fails, the UA *MUST* end the track (The UA *MAY* end it earlier should it detect a device problem, like the device being physically removed).

NOTE

The intent is to give users the assurance of privacy that having physical camera (and microphone) hardware lights off brings, by aligning physical and logical "privacy indicators", at least while the current document is the sole user of a device.

While other applications and documents using the device simultaneously may interfere with this intent at times, they do not interfere with the rules laid forth.

The muted/unmuted state of a track reflects whether the source provides any media at this moment. The enabled/disabled state is under application control and determines whether the track outputs media (to its consumers). Hence, media from the source only flows when a `MediaStreamTrack` object is both unmuted and enabled.

A `MediaStreamTrack` is muted when the source is temporarily unable to provide the track with data. A track can be muted by a user. Often this action is outside the control of the application. This could be as a result of the user hitting a hardware switch or toggling a control in the operating system / User Agent chrome. A track can also be muted by the User Agent.

Applications are able to enable or disable a `MediaStreamTrack` to prevent it from rendering media from the source. A muted track will however, regardless of the enabled state, render silence and blackness. A disabled track is logically equivalent to a muted track, from a consumer point of view.

For a newly created `MediaStreamTrack` object, the following applies. The track is always enabled unless stated otherwise (for example when cloned) and the muted state reflects the state of the source at the time the track is created.

A `MediaStreamTrack` object is said to *end* when the source of the track is disconnected or exhausted.

If all `MediaStreamTrack`s that are using the same source are ended, the source will be stopped.

When a `MediaStreamTrack` object ends for any reason (e.g., because the user rescinds the permission for the page to use the local camera, or because the application invoked the `stop()` method on the `MediaStreamTrack` object, or because the User Agent has instructed the track to end for any reason) it is said to be **ended**.

When a `MediaStreamTrack` *track* **ends for any reason other than the `stop()` method being invoked**, the User Agent *MUST* queue a task that runs the following steps:

1. If *track*.`readyState` has the value "`ended`" already, then abort these steps.

2. Set *track*.`readyState` to "`ended`".

3. Notify *track*'s source that *track* is ended so that the source may be stopped, unless other `MediaStreamTrack` objects depend on it.

4. Fire an event named ended at the object.

If the end of the track was reached due to a user request, the event source for this event is the user interaction event source.

To invoke the **device permission revocation algorithm** with `PermissionName` *permissionName* and `deviceId` *deviceId*, run the following steps:

1. Let *tracks* be the set of all currently "`live`" `MediaStreamTrack`s that fit the following criteria:
    - If *deviceId* is not `undefined`, tracks whose associated deviceId matches *deviceId*
    - If *deviceId* is `undefined`, tracks whose permission associated with this kind of track (e.g. "`camera`", "`microphone`") matches *permissionName*
2. For each *track* in *tracks*, end the track.

Media Flow §

There are two dimensions related to the media flow for a "`live`" `MediaStreamTrack` : muted / not muted, and enabled / disabled.

Muted refers to the input to the `MediaStreamTrack`. If live samples are not made available to the `MediaStreamTrack` it is muted.

Muted is out of control for the application, but can be observed by the application by reading the `muted` attribute and listening to the associated events `mute` and `unmute`. There can be several reasons for a `MediaStreamTrack` to be muted: the user pushing a physical mute button on the microphone, the user closing a laptop lid with an embedded camera, the user toggling a control in the operating system, the user clicking a mute button in the User Agent chrome, the User Agent (on behalf of the user) mutes, etc.

Whenever the User Agent initiates such a change, it *MUST* queue a task, using the user interaction task source, to set a track's muted state to the state desired by the user.

task, using the user interaction task source, to set a track's muted state to the state desired by the user.

To **set a track's muted state** to *newState*, the User Agent *MUST* run the following steps:

1. Let *track* be the `MediaStreamTrack` in question.
2. If *track*.`muted` is already *newState*, then abort these steps.
3. Set *track*.`muted` to *newState*.
4. If *newState* is `true` let *eventName* be `mute`, otherwise `unmute`.
5. Fire an event named *eventName* on *track*.

Enabled/disabled on the other hand is available to the application to control (and observe) via the `enabled` attribute.

The result for the consumer is the same in the sense that whenever `MediaStreamTrack` is muted or disabled (or both) the consumer gets zero-information-content, which means silence for audio and black frames for video. In other words, media from the source only flows when a `MediaStreamTrack` object is both unmuted and enabled. For example, a video element sourced by a muted or disabled `MediaStreamTrack` (contained in a `MediaStream`), is playing but rendering blackness.

For a newly created `MediaStreamTrack` object, the following applies: the track is always enabled unless stated otherwise (for example when cloned) and the muted state reflects the state of the source at the time the track is created.

4.3.2 Tracks and Constraints §

`MediaStreamTrack` is a constrainable object as defined in the Constrainable Pattern section. Constraints are set on tracks and may affect sources.

Whether `Constraints` were provided at track initialization time or need to be established later at runtime, the APIs defined in the `ConstrainablePattern` Interface allow the retrieval and manipulation of the constraints currently established on a track.

Once ended, a track will continue exposing a **list of inherent constrainable track properties**. This list contains `deviceId`, `facingMode` and `groupId`.

4.3.3 Interface Definition §

WebIDL

```
[Exposed=Window]
```

```
interface MediaStreamTrack : EventTarget {
  readonly attribute DOMString kind;
  readonly attribute DOMString id;
  readonly attribute DOMString label;
  attribute boolean enabled;
  readonly attribute boolean muted;
  attribute EventHandler onmute;
  attribute EventHandler onunmute;
  readonly attribute MediaStreamTrackState readyState;
  attribute EventHandler onended;
  MediaStreamTrack clone();
  undefined stop();
  MediaTrackCapabilities getCapabilities();
  MediaTrackConstraints getConstraints();
  MediaTrackSettings getSettings();
  Promise<undefined> applyConstraints(optional MediaTrackConstraints
constraints = {});
};
```

Attributes §

`kind` of type `DOMString`, readonly

The **`kind`** attribute *MUST* return the string **`"audio"`** if this object represents an audio track or **`"video"`** if this object represents a video track.

`id` of type `DOMString`, readonly

When a `MediaStreamTrack` is created, the User Agent *MUST* generate an identifier string, and *MUST* initialize the object's `id` attribute to that string, unless the object is created as part of a special purpose algorithm that specifies how the stream id must be initialized. See `MediaStream.id` attribute for guidelines on how to generate such an identifier.

An example of an algorithm that specifies how the track id must be initialized is the algorithm to represent an incoming network component with a `MediaStreamTrack` object. [WEBRTC]

`id` attribute *MUST* return the value to which it was initialized when the object was created.

`label` of type `DOMString`, readonly

User Agents *MAY* label audio and video sources (e.g., "Internal microphone" or "External USB Webcam"). The **`label`** attribute *MUST* return the label of the object's corresponding source, if any. If the corresponding source has or had no label, the attribute *MUST* instead return the empty string.

`enabled` of type `boolean`

The **`enabled`** attribute controls the enabled state for the object.

On getting, the attribute *MUST* return the value to which it was last set. On setting, it *MUST* be set to the new value.

> ***NOTE***
>
> ***Thus, after a `MediaStreamTrack` has ended, its `enabled` attribute still changes value when set; it just doesn't do anything with that new value.***

`muted` of type `boolean`, readonly

The **`muted`** attribute *MUST* return `true` if the track is muted, and `false` otherwise.

***`onmute`* of type `EventHandler`**

The event type of this event handler is mute.

***`onunmute`* of type `EventHandler`**

The event type of this event handler is unmute.

`readyState` of type `MediaStreamTrackState`, readonly

The **`readyState`** attribute represents the state of the track. It *MUST* return the value as most recently set by the User Agent.

***`onended`* of type `EventHandler`**

The event type of this event handler is ended.

Methods §

`clone`

Clones this `MediaStreamTrack`.

When the `clone()` method is invoked, the User Agent *MUST* return the result of cloning this track.

`stop`

When a `MediaStreamTrack` object's **`stop()`** method is invoked, the User Agent *MUST* run following steps:

1. Let *track* be the current `MediaStreamTrack` object.
2. If *track*.`readyState` is "`ended`", then abort these steps.

3. Notify *track*'s source that *track* is ended.

   A source that is notified of a track ending will be stopped, unless other `MediaStreamTrack` objects depend on it.

4. Set *track*.`readyState` to "`ended`".

`getCapabilities`

Returns the capabilites of the source that this `MediaStreamTrack`, the constrainable object, represents.

See ConstrainablePattern Interface for the definition of this method.

Since this method gives likely persistent, cross-origin information about the underlying device, it adds to the fingerprint surface of the device.

`getConstraints`

See ConstrainablePattern Interface for the definition of this method.

`getSettings`

When a `MediaStreamTrack` object's `MediaStreamTrack`.`getSettings()` method is invoked, the User Agent *MUST* run following steps:

1. Let *track* be the current `MediaStreamTrack` object.
2. If *track*.`MediaStreamTrack`.`readyState` is "`ended`", run the following sub steps:
   1. Let *settings* be a new `MediaTrackSettings` dictionary.
   2. For each *property* of the list of inherent constrainable track properties, add a corresponding property to *settings* if *track* had such property at the time it was ended, with the value at the time *track* was ended.
   3. Return *settings*.
3. Return the current settings of the track as defined in ConstrainablePattern Interface.

`applyConstraints`

When a `MediaStreamTrack` object's `applyConstraints()` method is invoked, the User Agent *MUST* run following steps:

1. Let *track* be the current `MediaStreamTrack` object.
2. If *track*.`readyState` is "`ended`", run the following sub steps:

    1. Let *p* be a new promise.
    2. resolve *p* with `undefined`.
    3. Return *p*.

3. Invoke and return the result of the applyConstraints template method where:
    - In the SelectSettings algorithm,
        - *object* is the `MediaStreamTrack` on which this method was called, and
        - settings dictionary refers to a possible instance of the `MediaTrackSettings` dictionary.
    - In step 3 of the ApplyConstraints algorithm, all changes listed are to be made to *object*, and
    - In step 4 of the ApplyConstraints algorithm, the requirement on getConstraints() applies to the getConstraints() method of *object*.

WebIDL

```
enum MediaStreamTrackState {
  "live",
  "ended"
};
```

`MediaStreamTrackState` Enumeration description

`live`	The track is active (the track's underlying media source is making a best-effort attempt to provide data in real time). The output of a track in the "`live`" state can be switched on and off with the `enabled` attribute.
`ended`	The track has ended (the track's underlying media source is no longer providing data, and will never provide more data for this track). Once a track enters this state, it never exits it. For example, a video track in a `MediaStream` ends when the user unplugs the USB web camera that acts as the track's media source.

4.3.4 `MediaTrackSupportedConstraints` §

`MediaTrackSupportedConstraints` represents the list of constraints recognized by a User Agent for controlling the Capabilities of a `MediaStreamTrack` object. This dictionary is used as a function return value, and never as an operation argument.

Future specifications can extend the `MediaTrackSupportedConstraints` dictionary by defining a partial dictionary with dictionary members of type `boolean`.

NOTE

The constraints specified in this specification apply only to instances of `MediaStreamTrack` generated by `MediaDevices.getUserMedia()`, unless stated otherwise in other specifications.

WebIDL

```
dictionary MediaTrackSupportedConstraints {
  boolean width = true;
  boolean height = true;
  boolean aspectRatio = true;
  boolean frameRate = true;
  boolean facingMode = true;
  boolean resizeMode = true;
  boolean sampleRate = true;
  boolean sampleSize = true;
  boolean echoCancellation = true;
  boolean autoGainControl = true;
  boolean noiseSuppression = true;
  boolean latency = true;
  boolean channelCount = true;
  boolean deviceId = true;
  boolean groupId = true;
};
```

Dictionary `MediaTrackSupportedConstraints` Members §

`width` **of type `boolean`, defaulting to `true`**

See width for details.

`height` **of type `boolean`, defaulting to `true`**

See height for details.

`aspectRatio` **of type `boolean`, defaulting to `true`**
See aspectRatio for details.

`frameRate` **of type `boolean`, defaulting to `true`**
See frameRate for details.

`facingMode` **of type `boolean`, defaulting to `true`**
See facingMode for details.

`resizeMode` **of type `boolean`, defaulting to `true`**
See resizeMode for details.

`sampleRate` **of type `boolean`, defaulting to `true`**
See sampleRate for details.

`sampleSize` **of type `boolean`, defaulting to `true`**
See sampleSize for details.

`echoCancellation` **of type `boolean`, defaulting to `true`**
See echoCancellation for details.

`autoGainControl` **of type `boolean`, defaulting to `true`**
See autoGainControl for details.

`noiseSuppression` **of type `boolean`, defaulting to `true`**
See noiseSuppression for details.

`latency` **of type `boolean`, defaulting to `true`**
See latency for details.

`channelCount` **of type `boolean`, defaulting to `true`**
See channelCount for details.

`deviceId` **of type `boolean`, defaulting to `true`**
See deviceId for details.

`groupId` **of type `boolean`, defaulting to `true`**
See groupId for details.

4.3.5 `MediaTrackCapabilities` §

`MediaTrackCapabilities` represents the Capabilities of a `MediaStreamTrack` object.

Future specifications can extend the MediaTrackCapabilities dictionary by defining a partial dictionary with dictionary members of appropriate type.

WebIDL

```
dictionary MediaTrackCapabilities {
  ULongRange width;
  ULongRange height;
  DoubleRange aspectRatio;
  DoubleRange frameRate;
  sequence<DOMString> facingMode;
  sequence<DOMString> resizeMode;
  ULongRange sampleRate;
  ULongRange sampleSize;
  sequence<boolean> echoCancellation;
  sequence<boolean> autoGainControl;
  sequence<boolean> noiseSuppression;
  DoubleRange latency;
  ULongRange channelCount;
  DOMString deviceId;
  DOMString groupId;
};
```

Dictionary `MediaTrackCapabilities` Members §

`width` **of type `ULongRange`**
: See width for details.

`height` **of type `ULongRange`**
: See height for details.

`aspectRatio` **of type `DoubleRange`**
: See aspectRatio for details.

`frameRate` **of type `DoubleRange`**
: See frameRate for details.

`facingMode` **of type `sequence<DOMString>`**
: A camera can report multiple facing modes. For example, in a high-end telepresence solution with several cameras facing the user, a camera to the left of the user can report both "`left`" and "`user`". See facingMode for additional details.

`resizeMode` **of type `sequence<DOMString>`**
: The User Agent *MAY* use cropping and downscaling to offer more resolution choices than this camera naturally produces. The reported sequence *MUST* list all the means the UA may employ to derive resolution choices for this camera. The value "`none`" *MUST* be present, indicating the ability to constrain the UA from cropping and downscaling. See resizeMode for additional details.

sampleRate **of type** `ULongRange`
: See sampleRate for details.

sampleSize **of type** `ULongRange`
: See sampleSize for details.

echoCancellation **of type** `sequence<boolean>`
: If the source cannot do echo cancellation a single `false` is reported. If echo cancellation cannot be turned off, a single `true` is reported. If the script can control the feature, the source reports a list with both `true` and `false` as possible values. See echoCancellation for additional details.

autoGainControl **of type** `sequence<boolean>`
: If the source cannot do auto gain control a single `false` is reported. If auto gain control cannot be turned off, a single `true` is reported. If the script can control the feature, the source reports a list with both `true` and `false` as possible values. See autoGainControl for additional details.

noiseSuppression **of type** `sequence<boolean>`
: If the source cannot do noise suppression a single `false` is reported. If noise suppression cannot be turned off, a single `true` is reported. If the script can control the feature, the source reports a list with both `true` and `false` as possible values. See noiseSuppression for additional details.

latency **of type** `DoubleRange`
: See latency for details.

channelCount **of type** `ULongRange`
: See channelCount for details.

deviceId **of type** `DOMString`
: See deviceId for details.

groupId **of type** `DOMString`
: See groupId for details.

4.3.6 `MediaTrackConstraints` §

WebIDL

```
dictionary MediaTrackConstraints : MediaTrackConstraintSet {
  sequence<MediaTrackConstraintSet> advanced;
};
```

Dictionary `MediaTrackConstraints` Members §

`advanced` **of type** **`sequence<MediaTrackConstraintSet>`**

See Constraints and ConstraintSet for the definition of this element.

Future specifications can extend the **`MediaTrackConstraintSet`** dictionary by defining a partial dictionary with dictionary members of appropriate type.

WebIDL

```
dictionary MediaTrackConstraintSet {
  ConstrainULong width;
  ConstrainULong height;
  ConstrainDouble aspectRatio;
  ConstrainDouble frameRate;
  ConstrainDOMString facingMode;
  ConstrainDOMString resizeMode;
  ConstrainULong sampleRate;
  ConstrainULong sampleSize;
  ConstrainBoolean echoCancellation;
  ConstrainBoolean autoGainControl;
  ConstrainBoolean noiseSuppression;
  ConstrainDouble latency;
  ConstrainULong channelCount;
  ConstrainDOMString deviceId;
  ConstrainDOMString groupId;
};
```

Dictionary `MediaTrackConstraintSet` Members §

`width` **of type** **`ConstrainULong`**

See width for details.

`height` **of type** **`ConstrainULong`**

See height for details.

`aspectRatio` **of type** **`ConstrainDouble`**

See aspectRatio for details.

`frameRate` **of type** **`ConstrainDouble`**

See frameRate for details.

`facingMode` **of type** **`ConstrainDOMString`**

See facingMode for details.

`resizeMode` **of type** **`ConstrainDOMString`**

See resizeMode for details.

sampleRate **of type** `ConstrainULong`
: See sampleRate for details.

sampleSize **of type** `ConstrainULong`
: See sampleSize for details.

echoCancellation **of type** `ConstrainBoolean`
: See echoCancellation for details.

autoGainControl **of type** `ConstrainBoolean`
: See autoGainControl for details.

noiseSuppression **of type** `ConstrainBoolean`
: See noiseSuppression for details.

latency **of type** `ConstrainDouble`
: See latency for details.

channelCount **of type** `ConstrainULong`
: See channelCount for details.

deviceId **of type** `ConstrainDOMString`
: See deviceId for details.

groupId **of type** `ConstrainDOMString`
: See groupId for details.

4.3.7 `MediaTrackSettings` §

`MediaTrackSettings` represents the Settings of a `MediaStreamTrack` object.

Future specifications can extend the MediaTrackSettings dictionary by defining a partial dictionary with dictionary members of appropriate type.

WebIDL

```
dictionary MediaTrackSettings {
  long width;
  long height;
  double aspectRatio;
  double frameRate;
  DOMString facingMode;
  DOMString resizeMode;
  long sampleRate;
  long sampleSize;
  boolean echoCancellation;
  boolean autoGainControl;
```

```
    boolean noiseSuppression;
    double latency;
    long channelCount;
    DOMString deviceId;
    DOMString groupId;
  };
```

Dictionary `MediaTrackSettings` Members §

`width` **of type `long`**
: See width for details.

`height` **of type `long`**
: See height for details.

`aspectRatio` **of type `double`**
: See aspectRatio for details.

`frameRate` **of type `double`**
: See frameRate for details.

`facingMode` **of type `DOMString`**
: See facingMode for details.

`resizeMode` **of type `DOMString`**
: See resizeMode for details.

`sampleRate` **of type `long`**
: See sampleRate for details.

`sampleSize` **of type `long`**
: See sampleSize for details.

`echoCancellation` **of type `boolean`**
: See echoCancellation for details.

`autoGainControl` **of type `boolean`**
: See autoGainControl for details.

`noiseSuppression` **of type `boolean`**
: See noiseSuppression for details.

`latency` **of type `double`**
: See latency for details.

`channelCount` **of type `long`**
: See channelCount for details.

`deviceId` **of type `DOMString`**

See deviceId for details.

`groupId` **of type `DOMString`**

See groupId for details.

4.3.8 Constrainable Properties §

The names of the initial set of constrainable properties for MediaStreamTrack are defined below.

The following constrainable properties are defined to apply to both video and audio `MediaStreamTrack` objects:

Property Name	Values	Notes
deviceId	DOMString	The identifier of the device generating the content of the `MediaStreamTrack`. It conforms with the definition of `MediaDeviceInfo`.`deviceId`. Note that the setting of this property is uniquely determined by the source that is attached to the `MediaStreamTrack`. In particular, `getCapabilities()` will return only a single value for deviceId. This property can therefore be used for initial media selection with `getUserMedia()`. However, it is not useful for subsequent media control with `applyConstraints()`, since any attempt to set a different value will result in an unsatisfiable `ConstraintSet`. If a string of length 0 is used as a deviceId value constraint with `getUserMedia()`, it *MAY* be interpreted as if the constraint is not specified.
groupId	`DOMString`	The document-unique group identifier for the device generating the content of the `MediaStreamTrack`. It conforms with the definition of `MediaDeviceInfo`.`groupId`. Note that the setting of this property is uniquely determined by the source that is attached to the `MediaStreamTrack`. In particular, `getCapabilities()` will return only a single value for groupId. Since this property is not stable between browsing sessions, its usefulness for initial media selection with `getUserMedia()` is limited. It is not useful for subsequent media control with `applyConstraints()`, since any attempt to set a different value will result in an unsatisfiable `ConstraintSet`.

The following constrainable properties are defined to apply only to video `MediaStreamTrack` objects:

Property Name	Values	Notes
width	`ConstrainULong`	The width or width range, in pixels. As a capability, the range should span the video source's pre-set width values with min being equal to 1 and max being the largest width. The User Agent *MUST* support downsampling to any value between the min width range value and the native resolution width.
height	`ConstrainULong`	The height or height range, in pixels. As a capability, the range should span the video source's pre-set height values with min being equal to 1 and max being the largest height. The User Agent *MUST* support downsampling to any value between the min height range value and the native resolution height.
frameRate	`ConstrainDouble`	The exact frame rate (frames per second) or frame rate range. If video source's pre-set can determine frame rate values, the range, as a capacity, should span the video source's pre-set frame rate values with min being equal to 0 and max being the largest frame rate. The User Agent *MUST* support frame rates obtained from integral decimation of the native resolution frame rate. If this frame rate cannot be determined (e.g. the source does not natively provide a frame rate, or the frame rate cannot be determined from the source stream), then this value *MUST* refer to the User Agent's vsync display rate.
aspectRatio	`ConstrainDouble`	The exact aspect ratio (width in pixels divided by height in pixels, represented as a double rounded to the tenth decimal place) or aspect ratio range.
facingMode	`ConstrainDOMString`	This string (or each string, when a list) should be one of the members of `VideoFacingModeEnum`. The members describe the directions that the camera can face, as seen from the user's perspective. Note that `getConstraints` may not return exactly the same string for strings not in this enum. This preserves the possibility of using a future version of WebIDL enum for this property.
resizeMode	`ConstrainDOMString`	This string (or each string, when a list) should be one of the members of `VideoResizeModeEnum`. The members

Property Name	Values	Notes
		describe the means by which the resolution can be derived by the UA. In other words, whether the UA is allowed to use cropping and downscaling on the camera output. The UA *MAY* disguise concurrent use of the camera, by cropping and/or downscaling to mimic native resolutions when "none" is used, but only when the camera is in use in another browsing context. Note that `getConstraints` may not return exactly the same string for strings not in this enum. This preserves the possibility of using a future version of WebIDL enum for this property.

On systems where it's desirable to sometimes automatically flip the X and Y axis of the resulting captured video in response to ongoing environmental factors, the `width`, `height` and `aspectRatio` constraints and capabilities *MUST* remain unaffected in all algorithms and be considered in the primary orientation only, except for the `getSettings()` algorithm where settings for these constrainable properties *MUST* be flipped if necessary to match the returned dimensions of the captured video at any point in time.

The **primary orientation** of a system that supports flipping the X and Y axis of resulting captured video is defined by the User Agent for the particular system.

NOTE
On systems that support automatic switching between landscape and portrait mode, User Agents are encouraged to make landscape mode the primary orientation.

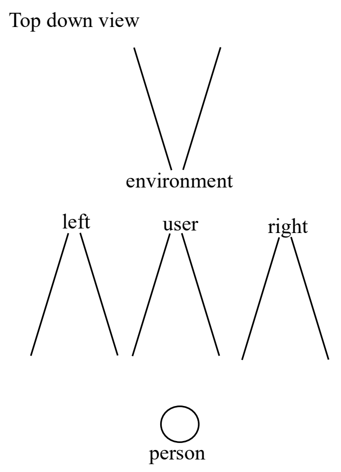
WebIDL

```
enum VideoFacingModeEnum {
  "user",
  "environment",
  "left",
  "right"
};
```

`VideoFacingModeEnum` Enumeration description

`user`	The source is facing toward the user (a self-view camera).
`environment`	The source is facing away from the user (viewing the environment).
`left`	The source is facing to the left of the user.
`right`	The source is facing to the right of the user.

Below is an illustration of the video facing modes in relation to the user.



WebIDL

```
enum VideoResizeModeEnum {
  "none",
  "crop-and-scale"
};
```

`VideoResizeModeEnum` Enumeration description

`none`	This resolution is offered by the camera, its driver, or the OS. Note: The UA *MAY* report this value to disguise concurrent use, but only when the

	camera is in use in another browsing context.
`crop-and-scale`	This resolution is downscaled and/or cropped from a higher camera resolution by the User Agent. The media *MUST NOT* be upscaled, stretched or have fake data created that did not occur in the input source.

The following constrainable properties are defined to apply only to audio `MediaStreamTrack` objects:

Property Name	Values	Notes
sampleRate	`ConstrainULong`	The sample rate in samples per second for the audio data.
sampleSize	`ConstrainULong`	The linear sample size in bits. This constraint can only be satisfied for audio devices that produce linear samples.
echoCancellation	`ConstrainBoolean`	When one or more audio streams is being played in the processes of various microphones, it is often desirable to attempt to remove all the sound being played from the input signals recorded by the microphones. This is referred to as echo cancellation. There are cases where it is not needed and it is desirable to turn it off so that no audio artifacts are introduced. This allows applications to control this behavior.
autoGainControl	`ConstrainBoolean`	Automatic gain control is often desirable on the input signal recorded by the microphone. There are cases where it is not needed and it is desirable to turn it off so that the audio is not altered. This allows applications to control this behavior.
noiseSuppression	`ConstrainBoolean`	Noise suppression is often desirable on the input signal recorded by the microphone. There are cases where it is not needed and it is desirable to turn it off so that the audio is not altered. This allows applications to control this behavior.
latency	`ConstrainDouble`	The latency or latency range, in seconds. The latency is the time between start of processing (for instance, when sound occurs in the real world) to the data being

Property Name	Values	Notes
		available to the next step in the process. Low latency is critical for some applications; high latency may be acceptable for other applications because it helps with power constraints. The number is expected to be the target latency of the configuration; the actual latency may show some variation from that.
channelCount	`ConstrainULong`	The number of independent channels of sound that the audio data contains, i.e. the number of audio samples per sample frame.

4.4 `MediaStreamTrackEvent` §

The `addtrack` and `removetrack` events use the `MediaStreamTrackEvent` interface.

The `addtrack` and `removetrack` events notify the script that the track set of a `MediaStream` has been updated by the User Agent.

Firing a track event named e with a `MediaStreamTrack` *track* means that an event with the name *e*, which does not bubble (except where otherwise stated) and is not cancelable (except where otherwise stated), and which uses the `MediaStreamTrackEvent` interface with the `track` attribute set to *track*, *MUST* be created and dispatched at the given target.

WebIDL

```
[Exposed=Window]
interface MediaStreamTrackEvent : Event {
  constructor(DOMString type, MediaStreamTrackEventInit eventInitDict);
  [SameObject] readonly attribute MediaStreamTrack track;
};
```

Constructors §

`constructor()`

Constructs a new `MediaStreamTrackEvent`.

Attributes §

`track` of type `MediaStreamTrack`, readonly

The **`track`** attribute represents the `MediaStreamTrack` object associated with the event.

WebIDL

```
dictionary MediaStreamTrackEventInit : EventInit {
  required MediaStreamTrack track;
};
```

Dictionary `MediaStreamTrackEventInit` Members §

`track` **of type `MediaStreamTrack`, required**

5. The model: sources, sinks, constraints, and settings §

This section is non-normative.

User Agents provide a media pipeline from sources to sinks. In a User Agent, sinks are the <`img`>, <`video`>, and <`audio`> tags. Traditional sources include streamed content, files, and web resources. The media produced by these sources typically does not change over time - these sources can be considered to be static.

The sinks that display these sources to the user (the actual tags themselves) have a variety of controls for manipulating the source content. For example, an <`img`> tag scales down a huge source image of 1600x1200 pixels to fit in a rectangle defined with `width="400"` and `height="300"`.

The getUserMedia API adds dynamic sources such as microphones and cameras - the characteristics of these sources can change in response to application needs. These sources can be considered to be dynamic in nature. A <`video`> element that displays media from a dynamic source can either perform scaling or it can feed back information along the media pipeline and have the source produce content more suitable for display.

NOTE

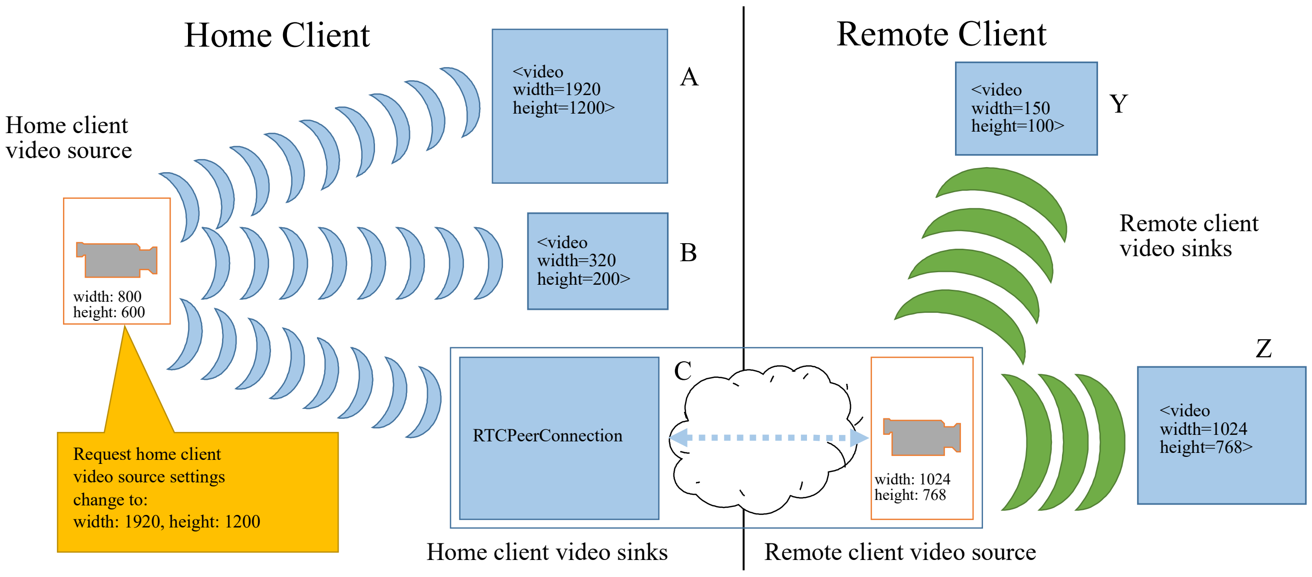
Note: This sort of feedback loop is obviously just enabling an "optimization", but it's a non-trivial gain. This optimization can save battery, allow for less network congestion, etc...

Note that `MediaStream` sinks (such as <`video`>, <`audio`>, and even `RTCPeerConnection`) will continue to have mechanisms to further transform the source stream beyond that which the Settings, Capabilities, and `Constraints` described in this specification offer. (The sink transformation options, including those of `RTCPeerConnection`, are outside the scope of this specification.)

The act of changing or applying a track constraint may affect the settings of all tracks sharing that source and consequently all down-level sinks that are using that source. Many sinks may be able to take these changes in stride, such as the `<video>` element or `RTCPeerConnection`. Others like the Recorder API may fail as a result of a source setting change.

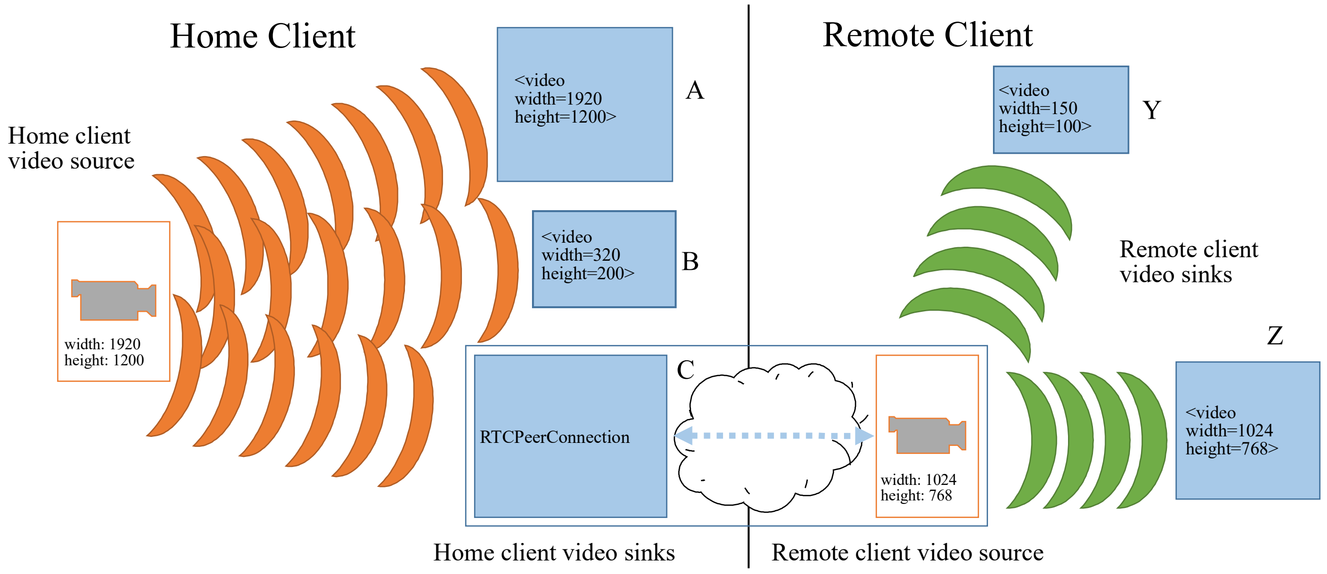
The `RTCPeerConnection` is an interesting object because it acts simultaneously as both a sink **and** a source for over-the-network streams. As a sink, it has source transformational capabilities (e.g., lowering bit-rates, scaling-up / down resolutions, and adjusting frame-rates), and as a source it could have its own settings changed by a track source.

To illustrate how changes to a given source impact various sinks, consider the following example. This example only uses width and height, but the same principles apply to all of the Settings exposed in this specification. In the first figure a home client has obtained a video source from its local video camera. The source's width and height settings are 800 pixels and 600 pixels, respectively. Three `MediaStream` objects on the home client contain tracks that use this same <`deviceId`. The three media streams are connected to three different sinks: a `<video>` element (A), another `<video>` element (B), and a peer connection (C). The peer connection is streaming the source video to a remote client. On the remote client there are two media streams with tracks that use the peer connection as a source. These two media streams are connected to two `<video>` element sinks (Y and Z).


Home Client
Remote Client
Home client video source
<video width=1920 height=1200>
A
<video width=320 height=200>
B
width: 800 height: 600
Request home client video source settings change to: width: 1920, height: 1200
RTCPeerConnection
C
width: 1024 height: 768
<video width=150 height=100>
Y
Remote client video sinks
Z
<video width=1024 height=768>
Home client video sinks
Remote client video source

Note that at this moment, all of the sinks on the home client must apply a transformation to the original source's provided dimension settings. B is scaling the video down, A is scaling the video up (resulting in loss of quality), and C is also scaling the video up slightly for sending over the network. On the remote client, sink Y is scaling the video *way* down, while sink Z is not applying any scaling.

In response to `applyConstraints()` being called, one of the tracks wants a higher resolution (1920 by 1200 pixels) from the home client's video source.

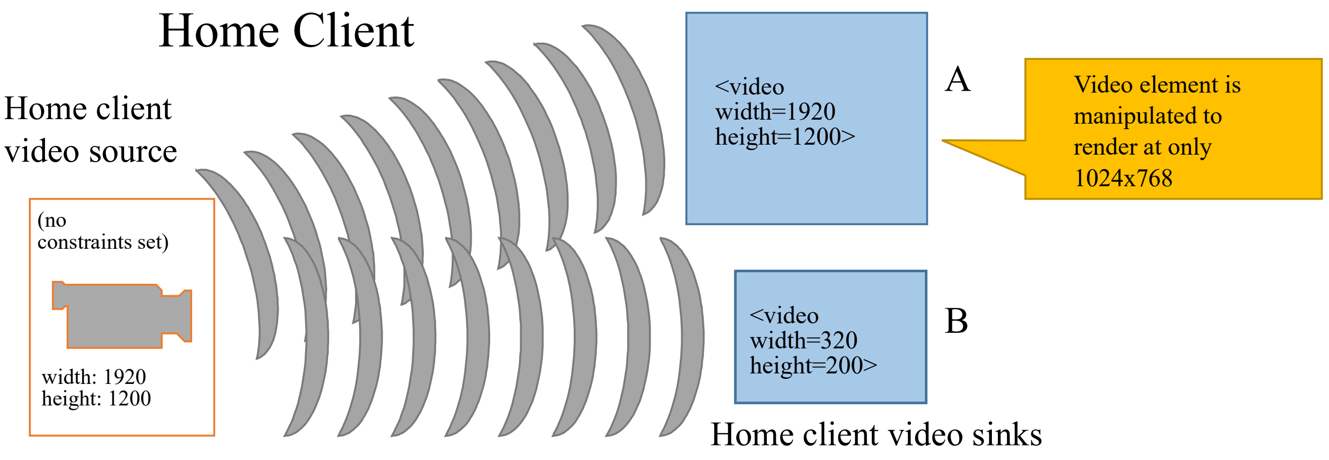

Home Client
Remote Client
Home client video source
width: 1920 height: 1200
<video width=1920 height=1200>
A
<video width=320 height=200>
B
C
RTCPeerConnection
width: 1024 height: 768
<video width=150 height=100>
Y
Remote client video sinks
Z
<video width=1024 height=768>
Home client video sinks
Remote client video source

Note that the source change immediately affects all of the tracks and sinks on the home client, but does not impact any of the sinks (or sources) on the remote client. With the increase in the home client source video's dimensions, sink A no longer has to perform any scaling, while sink B must scale down even further than before. Sink C (the peer connection) must now scale down the video in order to keep the transmission constant to the remote client.

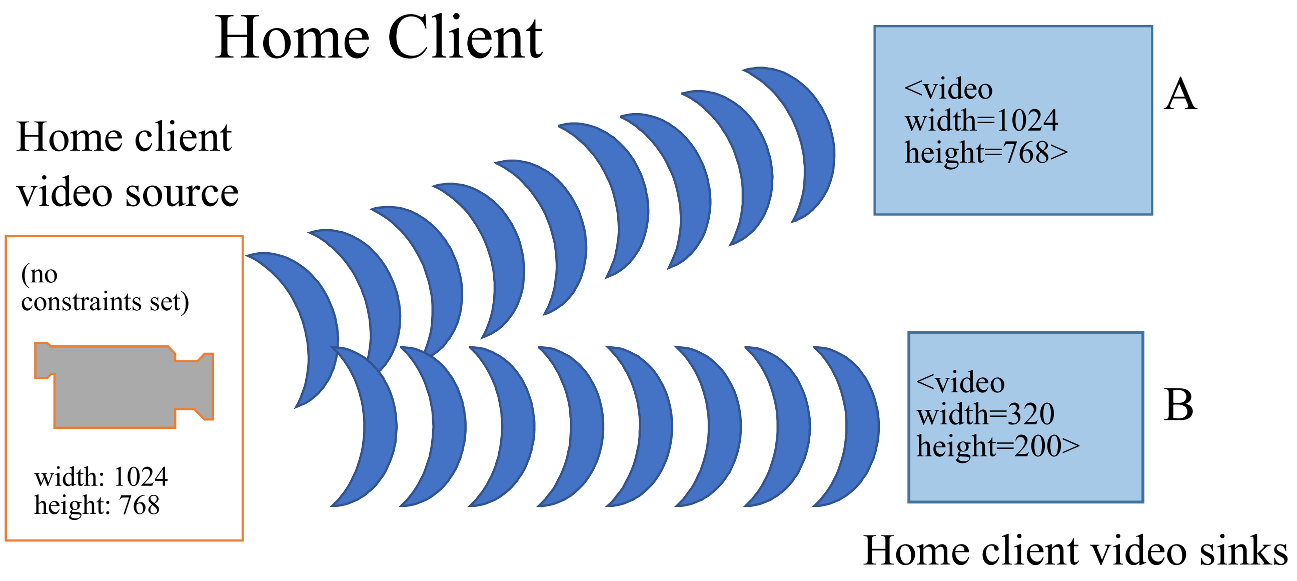
While not shown, an equally valid settings change request could be made on the remote client's side. In addition to impacting sink Y and Z in the same manner as A, B and C were impacted earlier, it could lead to re-negotiation with the peer connection on the home client in order to alter the transformation that it is applying to the home client's video source. Such a change is *NOT REQUIRED* to change anything related to sink A or B or the home client's video source.

Note that this specification does not define a mechanism by which a change to the remote client's video source could automatically trigger a change to the home client's video source. Implementations may choose to make such source-to-sink optimizations as long as they only do so within the constraints established by the application, as the next example demonstrates.

It is fairly obvious that changes to a given source will impact sink consumers. However, in some situations changes to a given sink may also cause implementations to adjust a source's settings. This is illustrated in the following figures. In the first figure below, the home client's video source is sending a video stream sized at 1920 by 1200 pixels. The video source is also unconstrained, such that the exact source dimensions are flexible as far as the application is concerned. Two `MediaStream` objects contain tracks with the same `deviceId`, and those `MediaStream`s are connected to two different `<video>` element sinks A and B. Sink A has been sized to `width="1920"` and `height="1200"` and is displaying the source's video content without any transformations. Sink B has been sized smaller and, as a result, is scaling the video down to fit its rectangle of 320 pixels across by 200 pixels down.


Home Client
Home client video source
(no constraints set)
width: 1920
height: 1200
<video width=1920 height=1200>
A
Video element is manipulated to render at only 1024x768
<video width=320 height=200>
B
Home client video sinks

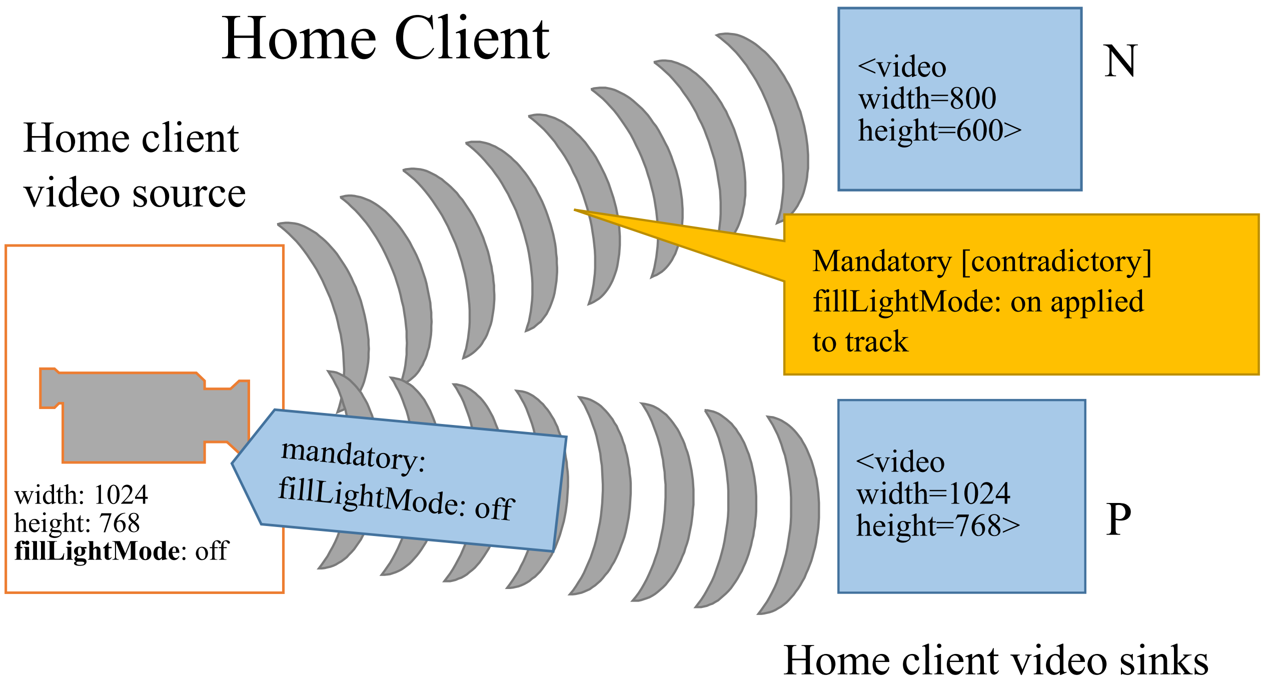
When the application changes sink A to a smaller dimension (from 1920 to 1024 pixels wide and from 1200 to 768 pixels tall), the User Agent's media pipeline may recognize that none of its sinks require the higher source resolution, and needless work is being done both on the part of the source and sink A. In such a case and without any other constraints forcing the source to continue producing the higher resolution video, the media pipeline *MAY* change the source resolution:



In the above figure, the home client's video source resolution was changed to the greater of that from sink A and B in order to optimize playback. While not shown above, the same behavior could apply to peer connections and other sinks.

It is possible that constraints can be applied to a track which a source is unable to satisfy, either because the source itself cannot satisfy the constraint or because the source is already satisfying a conflicting constraint. When this happens, the promise returned from `applyConstraints()` will be rejected, without applying any of the new constraints. Since no change in constraints occurs in this case, there is also no required change to the source itself as a result of this condition. Here is an example of this behavior.

In this example, two media streams each have a video track that share the same source. The first track initially has no constraints applied. It is connected to sink N. Sink N has a resolution of 800 by 600 pixels and is scaling down the source's resolution of 1024 by 768 to fit. The other track has a required constraint forcing off the source's fill light; it is connected to sink P. Sink P has a width and height equal to that of the source.


Home Client
Home client video source
width: 1024
height: 768
fillLightMode: off
mandatory: fillLightMode: off
Mandatory [contradictory] fillLightMode: on applied to track
<video width=800 height=600>
N
<video width=1024 height=768>
P
Home client video sinks

Now, the first track adds a required constraint that the fill light should be forced on. At this point, both required constraints cannot be satisfied by the source (the fill light cannot be simultaneously on and off at the same time). Since this state was caused by the first track's attempt to apply a conflicting constraint, the constraint application fails and there is no change in the source's settings nor to the constraints on either track.

6. MediaStreams in Media Elements §

A `MediaStream` may be assigned to media elements. A `MediaStream` is not preloadable or seekable and represents a simple, potentially infinite, linear media timeline. The timeline starts at 0 and increments linearly in real time as long as the media element is potentially playing. The timeline does not increment when the playout of the `MediaStream` is paused.

User Agents that support this specification *MUST* support the `srcObject` attribute of the `HTMLMediaElement` interface defined in [HTML], which includes support for playing `MediaStream` objects.

The [HTML] document outlines how the `HTMLMediaElement` works with a *media provider object*. The following applies when the *media provider object* is a `MediaStream`:

- Whenever an `AudioTrack` or a `VideoTrack` is created, the `id` and `label` attributes must be initialized to the corresponding attributes of the `MediaStreamTrack`, the `kind` attribute must be initialized to `"main"` and the `language` attribute to the empty string
- The User Agent *MUST* always play the current data from the `MediaStream` and *MUST NOT* buffer.
- Since the order in the `MediaStream` 's track set is undefined, no requirements are put on how the `AudioTrackList` and `VideoTrackList` is ordered
- If the element is an `HTMLVideoElement`, then it is said to have ended playback when it has **ended video playback**, which is when:
  1. The element's `readyState` is `HAVE_METADATA` or greater, and
     1. The `MediaStream` state is inactive after having been active, or
     2. The `MediaStream` state is active after having been inactive after having been active after `play()` was last called, and `autoplay` is `false`.

  NOTE
  Once playback has ended, it won't resume if new `MediaStreamTrack`s are added to the `MediaStream` unless `autoplay` is `true` or the element is restarted, e.g., by the web application calling play().

- If the element is an `HTMLAudioElement`, then it is said to have ended playback when it has **ended audio playback**, which is when:
  1. The element's `readyState` is `HAVE_METADATA` or greater, and
     1. The `MediaStream` state is inaudible after having been audible, or
     2. The `MediaStream` state is audible after having been inaudible after having been audible after `play()` was last called, and `autoplay` is `false`.

> ***NOTE***
> ***Once playback has ended, it won't resume if new audio `MediaStreamTrack`s are added to the `MediaStream` unless `autoplay` is `true` or the element is restarted, e.g., by the web application calling `play()`.***

- Any calls to the `fastSeek()` method on a `HTMLMediaElement` must be ignored

The nature of the `MediaStream` places certain restrictions on the behavior of attributes of the associated `HTMLMediaElement` and on the operations that can be performed on it, as shown below:

Attribute Name	Attribute Type	Setter/Getter Behavior When Provider is a MediaStream	Additional considerations
`preload`	`DOMString`	On getting: `none`. On setting: ignored.	A `MediaStream` cannot be preloaded.
`buffered`	`TimeRanges`	`buffered.length` *MUST* return `0`.	A `MediaStream` cannot be preloaded. Therefore, the amount buffered is always an empty time range.
`currentTime`	`double`	Any non-negative integer. The initial value is `0` and the values increments linearly in real time whenever the stream is playing.	The value is the official playback position, in seconds. Any attempt to alter it *MUST* be ignored.
`seeking`	`boolean`	`false`	A `MediaStream` is not seekable. Therefore, this attribute *MUST* always return the value `false`.
`defaultPlaybackRate`	`double`	On getting: `1.0`. On setting: ignored.	A `MediaStream` is not seekable. Therefore, this attribute *MUST* always return the value `1.0` and any attempt to alter it *MUST* be ignored. Note that this also means that

Attribute Name	Attribute Type	Setter/Getter Behavior When Provider is a MediaStream	Additional considerations
			the `ratechange` event will not fire.
`playbackRate`	`double`	On getting: `1.0`. On setting: ignored.	A `MediaStream` is not seekable. Therefore, this attribute *MUST* always return the value `1.0` and any attempt to alter it *MUST* be ignored. Note that this also means that the `ratechange` event will not fire.
`played`	`TimeRanges`	`played.length` *MUST* return `1`. `played.start(0)` *MUST* return `0`. `played.end(0)` *MUST* return the last known `currentTime`.	A `MediaStream`'s timeline always consists of a single range, starting at 0 and extending up to the currentTime.
`seekable`	`TimeRanges`	`seekable.length` *MUST* return `0`.	A `MediaStream` is not seekable.
`loop`	`boolean`	`true`, `false`	Setting the `loop` attribute has no effect since a `MediaStream` has no defined end and therefore cannot be looped.

Since none of the setters listed above alter internal state of the `HTMLMediaElement`, once a `MediaStream` is no longer the element's assigned media provider object, the attributes listed will appear to resume the values they had before a stream was assigned to the element.

NOTE

A `MediaStream` stops being the element's assigned media provider object when `srcObject` is assigned `null` or a non-stream object, just ahead of the media element load algorithm. As a result, the `ratechange` event may fire (from step 7) if `playbackRate` and `defaultPlaybackRate` were different from before a `MediaStream` was assigned.

7. Error Handling §

Some operations throw or fire `OverconstrainedError`. This is an extension of `DOMException` that carries additional information related to constraints failure.

7.1 OverconstrainedError Interface §

WebIDL

```
[Exposed=Window]
interface OverconstrainedError : DOMException {
  constructor(DOMString constraint, optional DOMString message = "");
  readonly attribute DOMString constraint;
};
```

7.1.1 Constructors §

`OverconstrainedError`

Run the following steps:

1. Let *constraint* be the constructor's first argument.
2. Let *message* be the constructor's second argument.
3. Let *e* be a new `OverconstrainedError` object.
4. Invoke the `DOMException` constructor of *e* with the `message` argument set to *message* and the `name` argument set to `"OverconstrainedError"`.

NOTE

This name does not have a mapping to a legacy code so e's `code` attribute will return 0.

5. Set *e.constraint* to *constraint*.

6. Return *e*.

7.1.2 Attributes §

`constraint` **of type `DOMString`, readonly**
The name of a constraint associated with this error, or `""` if no specific constraint name is revealed.

8. Event summary §

This section is non-normative.

The following events fire on `MediaStream` objects:

Event name	Interface	Fired when...
addtrack	`MediaStreamTrackEvent`	A new `MediaStreamTrack` has been added to this stream. Note that this event is not fired when the script directly modifies the tracks of a `MediaStream`.
removetrack	`MediaStreamTrackEvent`	A `MediaStreamTrack` has been removed from this stream. Note that this event is not fired when the script directly modifies the tracks of a `MediaStream`.

The following events fire on `MediaStreamTrack` objects:

Event name	Interface	Fired when...
mute	`Event`	The `MediaStreamTrack` object's source is temporarily unable to provide data.
unmute	`Event`	The `MediaStreamTrack` object's source is live again after having been temporarily unable to provide data.

ended	`Event`	The `MediaStreamTrack` object's source will no longer provide any data, either because the user revoked the permissions, or because the source device has been ejected, or because the remote peer permanently stopped sending data.

The following events fire on `MediaDevices` objects:

Event name	Interface	Fired when...
devicechange	`Event`	The set of media devices, available to the User Agent, has changed. The current list devices can be retrieved with the `enumerateDevices()` method.

9. Enumerating Local Media Devices §

This section describes an API that the script can use to query the User Agent about connected media input and output devices (for example a web camera or a headset).

9.1 `Navigator` Interface Extensions §

WebIDL

```
partial interface Navigator {
  [SameObject, SecureContext] readonly attribute MediaDevices mediaDevices;
};
```

Attributes §

`mediaDevices` **of type `MediaDevices`, readonly**
  Returns the `MediaDevices` object associated with this `Navigator` object.

9.2 `MediaDevices` §

The **`MediaDevices`** object is the entry point to the API used to examine and get access to media devices available to the User Agent.

On page load, run the following steps:

1. On the relevant global object, run the following steps:
    1. Create three internal slots: **[[devicesLiveMap]]**, **[[devicesAccessibleMap]]**, and **[[kindsAccessibleMap]]**, each initialized to a different empty object.
    2. Create one internal slot: **[[storedDeviceList]]**, initialized to `null`.
    3. Create one internal slot: **[[canExposeDeviceInfo]]**, initialized to `false`.
2. For each kind of device, *kind*, that `MediaDevices`.`getUserMedia()` exposes, set [[kindsAccessibleMap]]*[kind]* either to `true` if the result of reading the permission state of the permission associated with *kind* (e.g. "`camera`", "`microphone`"), is "`granted`", or to `false` otherwise.
3. For each individual device that `MediaDevices`.`getUserMedia()` exposes, using the device's deviceId, *deviceId*, set [[devicesLiveMap]]*[deviceId]* to `false`, and set [[devicesAccessibleMap]]*[deviceId]* either to `true` if the result of reading the permission state of the permission associated with the device’s kind and *deviceId*, is "`granted`", or to false otherwise.

For each kind of device, *kind*, that `getUserMedia()` exposes, whenever a transition occurs of the permission state of the permission associated with *kind*, run the following steps:

1. If the transition is to "`granted`" from another value, then set [[kindsAccessibleMap]]*[kind]* to `true`.
2. If the transition is from "`granted`" to another value, then set [[kindsAccessibleMap]]*[kind]* to `false`.

For each device that `getUserMedia()` exposes, whenever a transition occurs of the permission state of the permission associated with the device's kind and the device's deviceId, *deviceId*, run the following steps:

1. If the transition is to "`granted`" from another value, then set [[devicesAccessibleMap]]*[deviceId]* to `true`, if it isn’t already `true`.
2. If the transition is from "`granted`" to another value, and the device is currently stopped, then set [[devicesAccessibleMap]]*[deviceId]* to `false`.

When new media input and/or output devices of a `MediaDeviceKind` are made available where zero devices of that `MediaDeviceKind` were available before, or the lone input and/or output device of a

MediaDeviceKind becomes unavailable, the User Agent *MUST* run the following **device change notification steps** in browsing contexts for which device enumeration can proceed is true and device information can be exposed is false, but in no other contexts:

1. If [[storedDeviceList]] already lists the exact same set of devices in the same order as the list of devices that would be generated by a call to enumerateDevices now, then abort these steps.

   NOTE

   Due to the enumerateDevices algorithm, the above step limits firing the devicechange event to documents allowed to use enumerateDevices to enumerate devices of a particular MediaDeviceKind.

2. Set [[storedDeviceList]] to null.

3. Queue a task that fires a simple event named devicechange at the MediaDevices object.

   The User Agent *MAY* combine firing multiple events into firing one event when several events are due or when multiple devices are added or removed at the same time, e.g. a camera with a microphone.

Additionally, when new media input and/or output devices are made available, or any available input and/or output device becomes unavailable, or the system default for camera or microphone changed, the User Agent *MUST* run the device change notification steps in browsing contexts for which device enumeration can proceed is true and device information can be exposed is true, but in no other contexts.

In both cases above, if a browsing context that was traversed comes to meet the device enumeration can proceed criteria later (e.g. gains focus), the User Agent *MUST* execute the device change notification steps on the browsing context at that time.

NOTE

These events are potentially triggered simultaneously on documents of different origins. User Agents* MAY *add fuzzing on the timing of events to avoid cross-origin activity correlation.

WebIDL

```
[Exposed=Window, SecureContext]
interface MediaDevices : EventTarget {
  attribute EventHandler ondevicechange;
  Promise<sequence<MediaDeviceInfo>> enumerateDevices();
};
```

Attributes §

`ondevicechange` of type `EventHandler`

The event type of this event handler is devicechange.

Methods §

`enumerateDevices`

Collects information about the User Agent's available media input and output devices.

This method returns a promise. The promise will be fulfilled with a sequence of `MediaDeviceInfo` objects representing the User Agent's available media input and output devices if enumeration is successful.

Elements of this sequence that represent input devices will be of type `InputDeviceInfo` which extends `MediaDeviceInfo`.

Camera and microphone sources *SHOULD* be enumerable. Specifications that add additional types of source will provide recommendations about whether the source type should be enumerable.

When the `enumerateDevices()` method is called, the User Agent must run the following steps:

1. Let *p* be a new promise.

2. Run the following steps in parallel:

    1. Let *document* be the relevant settings object's responsible document.

    2. The User Agent *MUST* wait to proceed to the next step until device enumeration can proceed is `true`.

       The User Agent *MAY* wait to proceed to the next step until *document* is fully active and has focus.

    3. Let *resultList* be an empty list.

    4. If [[storedDeviceList]] is not `null`, run the following sub steps:

    1. For each `MediaDeviceInfo` object in [[storedDeviceList]], *storedDeviceInfo*:
        - Append to *resultList* a `MediaDeviceInfo` copy of *storedDeviceInfo*.
    2. resolve *p* with *resultList*.
    3. Abort these steps.

5. Probe the User Agent for available media devices, and let be *deviceList* be the list of all discovered devices.
6. Let *microphoneList*, *cameraList* and *otherDeviceList* be empty lists.
7. Run the following sub steps for each discovered device in *deviceList*, *device*:
    1. If *device* is not a microphone, or *document* is not allowed to use the feature identified by `"microphone"`, abort these sub steps and continue with the next device (if any).
    2. Let *deviceInfo* be the result of creating a device info object to represent *device*.
    3. If *device* is the system default microphone, prepend *deviceInfo* to *microphoneList*. Otherwise, append *deviceInfo* to *microphoneList*.
8. Run the following sub steps for each discovered device in *deviceList*, *device*:
    1. If *device* is not a camera, or *document* is not allowed to use the feature identified by `"camera"`, abort these sub steps and continue with the next device (if any).
    2. Let *deviceInfo* be the result of creating a device info object to represent *device*.
    3. If *device* is the system default camera, prepend *deviceInfo* to *cameraList*. Otherwise, append *deviceInfo* to *cameraList*.
9. If device information can be exposed is `false`, run the following sub steps:
    1. Add to *resultList* the first item of *microphoneList* if *microphoneList* is not empty.
    2. Add to *resultList* the first item of *cameraList* if *cameraList* is not empty.
10. Otherwise, run the following steps:
    1. Run the following sub steps for each discovered device in *deviceList*, *device*:
        1. If *device* is a microphone or *device* is a camera, abort these sub steps and

continue with the next device (if any).

2. Run the exposure decision algorithm for devices other than camera and microphone, with *device*, *microphoneList* and *cameraList* as input. If the result of this algorithm is `false`, abort these sub steps and continue with the next device (if any).

3. Let *deviceInfo* be the result of creating a device info object to represent *device*.

4. If *device* is the system default audio output, prepend *deviceInfo* to *otherDeviceList*. Otherwise, append *deviceInfo* to *otherDeviceList*.

 2. Append to *resultList* all devices of *microphoneList* in order.

 3. Append to *resultList* all devices of *cameraList* in order.

 4. Append to *resultList* all devices of *otherDeviceList* in order.

11. Set [[storedDeviceList]] to *resultList*.

12. resolve *p* with *resultList*.

3. Return *p*.

Since this method returns persistent information across browsing sessions and origins via the availability of media capture devices, it adds to the fingerprinting surface exposed by the User Agent.

As long as the responsible document did not capture, this method will limit exposure to two bits of information: whether there is a camera and whether there is a microphone. A User Agent may mitigate this by pretending the system has a camera and a microphone, for instance until the responsible document calls `getUserMedia()` with constraints deemed reasonable.

After the responsible document started capture, it provides additional persistent cross-origin information via the list of all media capture devices, including their grouping and human readable labels associated with the capture devices, which further adds to the fingerprinting surface. A User Agent may limit exposure by sanitizing device labels. This could for instance mean removing user names found in labels, but keeping device manufacturer or model information. It is important that the sanitized labels allow users to identify the corresponding devices.

9.2.1 Access control model §

The algorithm described above means that the access to media device information depends on whether or not the responsible document did capture.

For camera and microphone devices, if the browsing context did not capture (i.e. `getUserMedia()` was not called or never resolved successfully), the `MediaDeviceInfo` object will contain a valid value for `kind` but empty strings for `deviceId`, `label`, and `groupId`. Additionally, at most one device of each `kind` will be listed in `enumerateDevices()` result.

Otherwise, the **`MediaDeviceInfo`** object will contain meaningful values for `deviceId`, `kind`, `label`, and `groupId`. All available devices are listed in `enumerateDevices()` result.

To perform **creating a device info object** to represent a discovered device, *device*, run the following steps:

1. Let *deviceInfo* be a new `MediaDeviceInfo` object to represent *device*.
2. Initialize *deviceInfo*.`kind` for *device*.
3. If *deviceInfo*.`kind` is equal to "audioinput" or "videoinput" and device information can be exposed is `false`, return *deviceInfo*
4. Initialize *deviceInfo*.`label` for *device*.
5. If a stored `deviceId` exists for *device*, initialize *deviceInfo*.`deviceId` to that value. Otherwise, let *deviceInfo*.`deviceId` be a newly generated unique identifier as described under `deviceId`.
6. If *device* belongs to the same physical device as a device already represented for *document*, initialize *deviceInfo*.`groupId` to the `groupId` value of the existing `MediaDeviceInfo` object. Otherwise, let *deviceInfo*.`groupId` be a newly generated unique identifier as described under `groupId`.
7. Return *deviceInfo*

9.2.2 Device information exposure §

To perform a **device enumeration can proceed** check, run the following steps:

1. If device information can be exposed is `true`, return `true`.
2. If the relevant settings object's responsible document is fully active and has focus, return `true`.
3. Return `false`.

To perform a **device information can be exposed** check, run the following steps:

1. If any of the local devices are attached to a live `MediaStreamTrack` in the relevant settings object's responsible document, return `true`.
2. Return [[canExposeDeviceInfo]].

9.2.3 Set device information exposure §

To **set the device information exposure**, with a *value* of type boolean, run the following steps:

1. If [[canExposeDeviceInfo]] is already *value*, abort these steps.
2. If *value* is `true`, set [[storedDeviceList]] to `null`.
3. Set [[canExposeDeviceInfo]] to *value*.

NOTE
A User Agent* MAY *at any point set the device information exposure back to `false`, for instance if the User Agent decides to revoke device access on a given browsing context.

9.2.4 Exposure decision algorithm for devices other than camera and microphone §

The **exposure decision algorithm for devices other than camera and microphone** takes a *device*, *microphoneList* and *cameraList* as input and returns a boolean to decide whether exposing the device to the web page or not.

By default, it returns `false`.

Other specifications can define the algorithm for specific device types.

9.3 Device Info §

WebIDL

```
[Exposed=Window, SecureContext]
interface MediaDeviceInfo {
  readonly attribute DOMString deviceId;
  readonly attribute MediaDeviceKind kind;
  readonly attribute DOMString label;
  readonly attribute DOMString groupId;
  [Default] object toJSON();
};
```

Attributes §

`deviceId` **of type `DOMString`, readonly**

The identifier of the represented device. The device *MUST* be uniquely identified by its identifier and its `kind`.

To to ensure stored identifiers are recognized, the identifier *MUST* be the same in documents of the same origin in top-level browsing contexts. In nested browsing contexts, the decision of whether or not the identifier is the same across documents, *MUST* follow the User Agent's partitioning rules for storage (such as `localStorage`), if any, to not interfere with mitigations for cross-site correlation. If the identifier can uniquely identify the user, then it *MUST* be un-guessable in documents from other origins to prevent the identifier from being used to correlate the same user across different origins. An identifier can be reused across origins as long as it is not tied to the user and can be guessed by other means, like the User-Agent string.

If any local devices have been attached to a live `MediaStreamTrack` in a page from this origin, or stored permission to access local devices has been granted to this origin, then this identifier *MUST* be persisted, except as detailed below. Unique and stable identifiers let the application save, identify the availability of, and directly request specific sources, across multiple visits.

However, as long as no local device has been attached to a live MediaStreamTrack in a page from this origin, and no stored permission to access local devices has been granted to this origin, then the User Agent *MAY* clear this identifier once the last browsing session from this origin has been closed. If the User Agent chooses not to clear the identifier in this condition, then it *MUST* provide for the user to visibly inspect and delete the identifier, like a cookie.

Since `deviceId` may persist across browsing sessions and to reduce its potential as a fingerprinting mechanism, `deviceId` is to be treated as other persistent storage mechanisms such as cookies [COOKIES], in that User Agents *MUST NOT* persist device identifiers for sites that are blocked from using cookies, and User Agents *MUST* rotate per-origin device identifiers when other persistent storage are cleared.

`kind` **of type `MediaDeviceKind`, readonly**

The kind of the represented device.

label **of type `DOMString`, readonly**

A label describing this device (for example "External USB Webcam"). This label is intended to allow the end user to tell the difference between devices. Applications can't assume that the label contains any specific information, such as the device type or model. If the device has no associated label, then this attribute *MUST* return the empty string.

groupId **of type `DOMString`, readonly**

The group identifier of the represented device. Two devices have the same group identifier if they belong to the same physical device. For example, the audio input and output devices representing the speaker and microphone of the same headset have the same groupId.

The group identifier *MUST* be uniquely generated for each document.

Methods §

toJSON

When called, run [WEBIDL]'s default toJSON steps.

WebIDL

```
enum MediaDeviceKind {
  "audioinput",
  "audiooutput",
  "videoinput"
};
```

`MediaDeviceKind` Enumeration description

audioinput	Represents an audio input device; for example a microphone.
audiooutput	Represents an audio output device; for example a pair of headphones.
videoinput	Represents a video input device; for example a webcam.

9.4 Input-specific Device Info §

The **`InputDeviceInfo`** interface gives access to the capabilities of the input device it represents.

WebIDL

```
[Exposed=Window]
interface InputDeviceInfo : MediaDeviceInfo {
  MediaTrackCapabilities getCapabilities();
};
```

Methods §

`getCapabilities`

Returns a `MediaTrackCapabilities` object describing the primary audio or video track of a device's `MediaStream` (according to its `kind` value), in the absence of any user-supplied constraints. These capabilities *MUST* be identical to those that would have been obtained by calling `getCapabilities()` on the first `MediaStreamTrack` of this type in a `MediaStream` returned by `getUserMedia({deviceId: id})` where *id* is the value of the `deviceId` attribute of this `MediaDeviceInfo`.

If no access has been granted to any local devices and this `InputDeviceInfo` has been filtered with respect to unique identifying information (see above description of `enumerateDevices()` result), then this method returns an empty dictionary.

10. Obtaining local multimedia content §

This section extends `Navigator` and `MediaDevices` with APIs to request permission to access media input devices available to the User Agent.

Alternatively, a local `MediaStream` can be captured from certain types of DOM elements, such as the video element [mediacapture-fromelement]. This can be useful for automated testing.

10.1 Legacy Interface Extensions §

NOTE

The definition of getUserMedia() in this section reflects two major changes from the method definition that has existed here for many months.
First, the official definition for the getUserMedia() method, and the one which developers are encouraged to use, is now at `MediaDevices`. This decision reflected consensus as long as the original API remained available here under the Navigator object for backwards compatibility reasons, since the working group acknowledges that early users of these APIs have been encouraged to define getUserMedia as "var getUserMedia = navigator.getUserMedia || navigator.webkitGetUserMedia || navigator.mozGetUserMedia;" in order for their code to be functional both before and after official implementations of getUserMedia() in popular User Agents. To ensure functional equivalence, the getUserMedia() method here is defined in terms of the method under MediaDevices.

Second, the decision to change all other callback-based methods in the specification to be based on Promises instead required that the navigator.getUserMedia() definition reflect this in its use of navigator.mediaDevices.getUserMedia(). Because navigator.getUserMedia() is now the only callback-based method remaining in the specification, there is ongoing discussion as to a) whether it still belongs in the specification, and b) if it does, whether its syntax should remain callback-based or change in some way to use Promises. Input on these questions is encouraged, particularly from developers actively using today's implementations of this functionality.

Note that the other methods that changed from a callback-based syntax to a Promises-based syntax were not considered to have been implemented widely enough in any form to have to consider legacy usage.

WebIDL

```
partial interface Navigator {
  [SecureContext] undefined getUserMedia(MediaStreamConstraints constraints,
                                         NavigatorUserMediaSuccessCallback
successCallback,
                                         NavigatorUserMediaErrorCallback
errorCallback);
};
```

Methods §

getUserMedia

Prompts the user for permission to use their Web cam or other video or audio input.

The *constraints* argument is a dictionary of type `MediaStreamConstraints`.

The *successCallback* will be invoked with a suitable `MediaStream` object as its argument if the user accepts valid tracks as described in `getUserMedia()` on `MediaDevices`.

The *errorCallback* will be invoked if there is a failure in finding valid tracks or if the user denies permission, as described in `getUserMedia()` on `MediaDevices`.

When the `getUserMedia()` method is called, the User Agent *MUST* run the following steps:

1. Let *constraints* be the method's first argument.
2. Let *successCallback* be the callback indicated by the method's second argument.
3. Let *errorCallback* be the callback indicated by the method's third argument.
4. Run the steps specified by the getUserMedia() algorithm with *constraints* as the argument, and let *p* be the resulting promise.
5. Upon fulfillment of *p* with value *stream*, run the following step:
    1. Invoke *successCallback* with *stream* as the argument.
6. Upon rejection of *p* with reason *r*, run the following step:
    1. Invoke *errorCallback* with *r* as the argument.

10.2 `MediaDevices` Interface Extensions §

NOTE

The definition of `getUserMedia()` in this section reflects two major changes from the method definition that has existed under `Navigator` for many months.

First, the official definition for the `getUserMedia()` method, and the one which developers are encouraged to use, is now the one defined here under `MediaDevices`. This decision reflected consensus as long as the original API remained available at `Navigator.getUserMedia` under the `Navigator` object for backwards compatibility reasons, since the working group acknowledges that early users of these APIs have been encouraged to define getUserMedia as "var getUserMedia = navigator.getUserMedia || navigator.webkitGetUserMedia || navigator.mozGetUserMedia;" in order for their code to be functional both before and after official implementations of getUserMedia() in popular User Agents. To ensure functional equivalence, the getUserMedia() method under `Navigator` is defined in terms of the method here.

Second, the method defined here is Promises-based, while the one defined under `Navigator` is currently still callback-based. Developers expecting to find getUserMedia() defined under Navigator are strongly encouraged to read the detailed Note given there.

The `getSupportedConstraints` method is provided to allow the application to determine which constraints the User Agent recognizes.

WebIDL

```
partial interface MediaDevices {
  MediaTrackSupportedConstraints getSupportedConstraints();
  Promise<MediaStream> getUserMedia(optional MediaStreamConstraints
constraints = {});
};
```

Methods §

`getSupportedConstraints`

Returns a dictionary whose members are the constrainable properties known to the User Agent. A supported constrainable property *MUST* be represented and any constrainable properties not supported by the User Agent *MUST NOT* be present in the returned dictionary. The values returned represent what the User Agent implements and will not change during a browsing session.

getUserMedia

Prompts the user for permission to use their Web cam or other video or audio input.

The *constraints* argument is a dictionary of type `MediaStreamConstraints`.

This method returns a promise. The promise will be fulfilled with a suitable `MediaStream` object if the user accepts valid tracks as described below.

The promise will be rejected if there is a failure in finding valid tracks or if the user denies permission, as described below.

When the **`getUserMedia()`** method is called, the User Agent *MUST* run the following steps:

1. Let *constraints* be the method's first argument.
2. Let *requestedMediaTypes* be the set of media types in *constraints* with either a dictionary value or a value of `true`.
3. If *requestedMediaTypes* is the empty set, return a promise rejected with a `TypeError`. The word "optional" occurs in the WebIDL due to WebIDL rules, but the argument *MUST* be supplied in order for the call to succeed.
4. If the relevant settings object's responsible document is NOT fully active, return a promise rejected with a `DOMException` object whose `name` attribute has the value "`InvalidStateError`".
5. Let *p* be a new promise.
6. Run the following steps in parallel:
    1. The User Agent *MUST* wait to proceed to the next step until the relevant settings object's responsible document is fully active and has focus.
    2. Let *finalSet* be an (initially) empty set.
    3. For each media type *kind* in *requestedMediaTypes*, run the following steps:
        1. For each possible source for media of type *kind*, construct an unconstrained MediaStreamTrack with that source as its source.

Call this set of tracks the *candidateSet*.

If *candidateSet* is the empty set, reject *p* with a new `DOMException` object whose `name` attribute has the value "`NotFoundError`" and abort these steps.

2. If the value of the *kind* entry of *constraints* is `true`, set *CS* to the empty constraint set (no constraint). Otherwise, continue with *CS* set to the value of the *kind* entry of *constraints*.
3. Remove any constrainable property inside of *CS* that are not defined for `MediaStreamTrack` objects of type *kind*. This means that audio-only constraints inside of `"video"` and video-only constraints inside of `"audio"` are simply ignored rather than causing `OverconstrainedError`.
4. If *CS* contains a member that is a required constraint and whose name is not in the list of allowed required constraints for device selection, then reject *p* with a `TypeError`, and abort these steps.
5. Run the SelectSettings algorithm on each track in *candidateSet* with *CS* as the constraint set. If the algorithm returns `undefined`, remove the track from *candidateSet*. This eliminates devices unable to satisfy the constraints, by verifying that at least one settings dictionary exists that satisfies the constraints.

   If *candidateSet* is the empty set, let *failedConstraint* be any required constraint whose fitness distance was infinity for all settings dictionaries examined while executing the SelectSettings algorithm, or `""` if there isn't one, and jump to the step labeled *Constraint Failure* below.

   This error gives information about what the underlying device is not capable of producing, before the user has given any authorization to any device, and can thus be used as a fingerprinting surface.
6. Read the current permission state for all candidate devices in *candidateSet* that are not attached to a live `MediaStreamTrack` in the current browsing context. Remove from *candidateSet* any device for which the permission state is "`denied`".

   If *candidateSet* is now empty, indicating that all devices of this type are in state "`denied`", jump to the step labeled *PermissionFailure* below.
7. Optionally, e.g., based on a previously-established user preference, for security reasons, or due to platform limitations, jump to the step labeled *Permission Failure* below.

8. Add all tracks from *candidateSet* to *finalSet*.

4. Let *stream* be a new and empty `MediaStream` object.

5. For each media type *kind* in *requestedMediaTypes*, run the following sub steps, preferably at the same time:

> ***NOTE***
> ***User Agents are encouraged to bundle concurrent requests for different kinds of media into a single user-facing permission prompt.***

1. Request permission to use a `PermissionDescriptor` with its `name` member set to the permission name associated with *kind* (e.g. "`camera`" for `"video"`, "`microphone`" for `"audio"`), and, optionally, consider its deviceId member set to any appropriate device's *deviceId*, while considering all devices attached to a live and same-permission `MediaStreamTrack` in the current browsing context to have permission status "`granted`", resulting in a set of provided media. **Same-permission** in this context means a `MediaStreamTrack` that required the same level of permission to obtain as what is being requested (e.g. not isolated).

   When asking the user's permission, the User Agent *MUST* disclose whether permission will be granted only to the device chosen, or to all devices of that *kind*.

   Let *track* be the provided media, which *MUST* be precisely one track of type *kind* from *finalSet*. The decision of which track to choose from the *finalSet* is completely up to the User Agent and may be determined by asking the user. Once selected, the source of the `MediaStreamTrack` *MUST NOT* change.

   The User Agent *SHOULD* use the value of the computed fitness distance from the SelectSettings algorithm as an input to the selection algorithm. However, it *MAY* also use other internally-available information about the devices, such as user preference.

   User Agents are encouraged to default to using the user's primary or system default device for *kind* (when possible). User Agents *MAY* allow users to use any media source, including pre-recorded media files.

2. If the user never responds, this algorithm stalls on this step.

3. If the result of the request is "`denied`", jump to the step labeled *Permission*

Failure below.

4. The result of the request is "`granted`". If a hardware error such as an OS/program /webpage lock prevents access, remove *track* from *finalSet*. If *finalSet* has no track of type *kind*, reject *p* with a new `DOMException` object whose `name` attribute has the value "`NotReadableError`" and abort these steps. Otherwise, restart these sub steps with the updated *finalSet*.

   If device access fails for any reason other than those listed above, remove *track* from *finalSet*. If *finalSet* has no track of type *kind*, reject *p* with a new `DOMException` object whose `name` attribute has the value "`AbortError`" and abort these steps. Otherwise, restart these sub steps with the updated *finalSet*.

5. Using the granted device's deviceId, *deviceId*, set [[devicesLiveMap]][*deviceId*] to `true`, if it isn't already `true`, and set the [[devicesAccessibleMap]][*deviceId*] to `true`, if it isn't already `true`.

6. Add *track* to *stream*'s track set.

6. Run the ApplyConstraints algorithm on all tracks in *stream* with the appropriate constraints. If any of them returns something other than `undefined`, let *failedConstraint* be that result and jump to the step labeled *Constraint Failure* below.

7. Set the device information exposure to `true`.

8. resolve *p* with *stream* and abort these steps.

9. *Permission Failure*: Reject *p* with a new `DOMException` object whose `name` attribute has the value "`NotAllowedError`".

10. *Constraint Failure*: Let *message* be either `undefined` or an informative human-readable message, let *constraint* be *failedConstraint* if device information can be exposed is `true`, or `""` otherwise, and then reject *p* with a new `OverconstrainedError` created by calling `OverconstrainedError(constraint, message)`.

7. Return *p*.

NOTE

In the algorithm above, constraints are checked twice - once at device selection, and once after access approval. Time may have passed between those checks, so it is conceivable that the selected device is no longer suitable. In this case, a NotReadableError will result.

The **allowed required constraints for device selection** contains the following constraint names: width, height, aspectRatio, frameRate, facingMode, resizeMode, sampleRate, sampleSize, echoCancellation, autoGainControl, noiseSuppression, latency, channelCount, deviceId, groupId.

10.3 `MediaStreamConstraints` §

The **`MediaStreamConstraints`** dictionary is used to instruct the User Agent what sort of `MediaStreamTrack`s to include in the `MediaStream` returned by `getUserMedia()`.

WebIDL

```
dictionary MediaStreamConstraints {
  (boolean or MediaTrackConstraints) video = false;
  (boolean or MediaTrackConstraints) audio = false;
};
```

Dictionary `MediaStreamConstraints` Members §

`video` **of type `(boolean or MediaTrackConstraints)`, defaulting to `false`**

If `true`, it requests that the returned `MediaStream` contain a video track. If a `Constraints` structure is provided, it further specifies the nature and settings of the video Track. If `false`, the `MediaStream` *MUST NOT* contain a video Track.

`audio` **of type `(boolean or MediaTrackConstraints)`, defaulting to `false`**

If `true`, it requests that the returned `MediaStream` contain an audio track. If a `Constraints` structure is provided, it further specifies the nature and settings of the audio Track. If `false`, the `MediaStream` *MUST NOT* contain an audio Track.

10.4 `NavigatorUserMediaSuccessCallback` §

WebIDL

```
callback NavigatorUserMediaSuccessCallback = undefined (MediaStream stream);
```

Callback `NavigatorUserMediaSuccessCallback` Parameters §

stream of type `MediaStream`

`MediaStream` object representing the stream to which the user granted permission as described in the `Navigator`.`getUserMedia` algorithm.

10.5 `NavigatorUserMediaErrorCallback` §

WebIDL

```
callback NavigatorUserMediaErrorCallback = undefined (DOMException error);
```

Callback `NavigatorUserMediaErrorCallback` Parameters §

error of type `DOMException`

Error in obtaining a `MediaStream` as described in the failure steps of the `Navigator`.`getUserMedia` algorithm.

10.6 Implementation Suggestions §

This section is non-normative.

Best Practice 1: Resource reservation

The User Agent is encouraged to reserve resources when it has determined that a given call to `getUserMedia()` will be successful. It is preferable to reserve the resource prior to resolving the returned promise. Subsequent calls to `getUserMedia()` (in this page or any other) should treat the resource that was previously allocated, as well as resources held by other applications, as busy. Resources marked as busy should not be provided as sources to the current web page, unless specified by the user. Optionally, the User Agent may choose to provide a stream sourced from a busy source but only to a page whose origin matches the owner of the original stream that is keeping the source busy.

This document recommends that in the permission grant dialog or device selection interface (if one is present), the user be allowed to select any available hardware as a source for the stream requested by the page (provided the resource is able to fulfill any specified required constraints). Although not specifically recommended as best practice, note that some User Agents may support the ability to substitute a video or audio source with local files and other media. A file picker may be used to provide this functionality to the user.

This document also recommends that the user be shown all resources that are currently busy as a result of prior calls to getUserMedia() (in this page or any other page that is still alive) and be allowed to terminate that stream and utilize the resource for the current page instead. If possible in the current operating environment, it is also suggested that resources currently held by other applications be presented and treated in the same manner. If the user chooses this option, the track corresponding to the resource that was provided to the page whose stream was affected must be removed.

Best Practice 2: **Stored Permission** s

When permission is requested for a device, the User Agent may choose to store this permission for later use by the same origin, so that the user does not need to grant permission again at a later time. It is a User Agent choice whether it offers functionality to store permission to each device separately, all devices of a given class, or all devices; the choice needs to be apparent to the user, and permission must have been granted for the entire set whose permission is being stored, e.g., to store permission to use all cameras the user must have given permission to use all cameras and not just one.

As described, this specification does not dictate whether or not granting permission results in a stored permission. When permission is not stored, permission will last only until such time as all MediaStreamTracks sourced from that device have been stopped.

Best Practice 3: Handling multiple devices

A `MediaStream` may contain more than one video and audio track. This makes it possible to include video from two or more webcams in a single stream object, for example. However, the current API does not allow a page to express a need for multiple video streams from independent sources.

It is recommended for multiple calls to getUserMedia() from the same page to be allowed as a way for pages to request multiple discrete video and/or audio streams.

Note also that if multiple getUserMedia() calls are done by a page, the order in which they request resources, and the order in which they complete, is not constrained by this specification.

A single call to getUserMedia() will always return a stream with either zero or one audio tracks, and either zero or one video tracks. If a script calls getUserMedia() multiple times before reaching a stable state, this document advises the UI designer that the permission dialogs should be merged, so that the user can give permission for the use of multiple cameras and/or media sources in one dialog interaction. The constraints on each getUserMedia call can be used to decide which stream gets which media sources.

Best Practice 4: Generating deviceIds

An efficient practice for generating a `deviceId` is to generate a cryptographic hash from a private key + (origin or origin + top-level origin, based on the user agents' partitioning rules) + salt + device's underlying (hardware) id in the driver, and present the resulting hash as an alphanumeric string. Using 32 bits or fewer for the hash is recommended, but not much lower, to avoid risk of collision.

A lower-entropy alternative, at the cost of storage, is to assign the numbers 0 through 255 randomly to each new device encountered for each origin or origin + top-level origin, based on the User Agent's partitioning rules, retiring the number that hasn't been seen the longest if numbers run out.

Best Practice 5: Device muting initiated by User Agent

A track sourced by a camera or microphone may be forcibly muted by a User Agent at any time, in order to manage a user's privacy. However, doing so may create web compatibility issues, as well as leak information about user activity, so caution is advised.

Best practice is to mute a camera or microphone track in the following instances:

- An OS-level event for which the User Agent already suspends media playback globally, but JavaScript is not suspended. The rationale is users may otherwise be surprised if capture were to continue in this situation (unless they've intentionally configured it this way). If the OS-level event already causes frames to stop coming in on the track, then no new information of user activity is revealed by this. Even when this is not the case, revealing that capture is ending seems like a reasonable privacy tradeoff compared to continuing capture in situations that may surprise users.
- A web page without focus re-enables a track when all tracks from that source are disabled, in order to delay resumption of capture until the page gains focus.

Best practice is to unmute a camera or microphone track it previously muted, in the following instances:

- An OS-level event for which the User Agent already resumes media playback globally, *and* the page is visible to the user (e.g. not during a lock screen). User Agents may defer such action if it determines significant time has passed that may jeopardize a user's awareness of the earlier capture session.
- A web page gains focus and has one or more enabled tracks that are also muted.

11. Constrainable Pattern §

The Constrainable pattern allows applications to inspect and adjust the properties of objects implementing it (the **constrainable object**). It is broken out as a separate set of definitions so that it can be referred to by other specifications. The core concept is the Capability, which consists of a constrainable property of an object and the set of its possible values, which may be specified either as a range or as an enumeration. For example, a camera might be capable of framerates (a property) between 20 and 50 frames per second (a range) and may be able to be positioned (a property) facing towards the user, away from the user, or to the left or right of the user (an enumerated set). The application can examine a constrainable property's supported Capabilities via the `getCapabilities()`

accessor.

The application can select the (range of) values it wants for an object's Capabilities by means of basic and/or advanced ConstraintSets and the `applyConstraints()` method. A ConstraintSet consists of the names of one or more properties of the object plus the desired value (or a range of desired values) for each property. Each of those property/value pairs can be considered to be an individual constraint. For example, the application may set a ConstraintSet containing two constraints, the first stating that the framerate of a camera be between 30 and 40 frames per second (a range) and the second that the camera should be facing the user (a specific value). How the individual constraints interact depends on whether and how they are given in the basic Constraint structure, which is a ConstraintSet with an additional 'advanced' property, or whether they are in a ConstraintSet in the advanced list. The behavior is as follows: all 'min', 'max', and 'exact' constraints in the basic Constraint structure are together treated as the required constraints, and if it is not possible to satisfy simultaneously all of those individual constraints for the indicated property names, the User Agent *MUST* reject the returned promise. Otherwise, it must apply the required constraints. Next, it will consider any ConstraintSets given in the `advanced` list, in the order in which they are specified, and will try to satisfy/apply each complete ConstraintSet (i.e., all constraints in the ConstraintSet together), but will skip a ConstraintSet if and only if it cannot satisfy/apply it in its entirety. Next, the User Agent *MUST* attempt to apply, individually, any 'ideal' constraints or a constraint given as a bare value for the property (referred to as optional basic constraints). Of these properties, it *MUST* satisfy the largest number that it can, in any order. Finally, the User Agent *MUST* resolve the returned promise.

NOTE
Any constraint provided via this API will only be considered if the given constrainable property is supported by the User Agent. JavaScript application code is expected to first check, via `getSupportedConstraints()`, that all the named properties that are used are supported by the User Agent. The reason for this is that WebIDL drops any unsupported names from the dictionary holding the constraints, so the User Agent does not see them and the unsupported names end up being silently ignored. This will cause confusing programming errors as the JavaScript code will be setting constraints but the User Agent will be ignoring them. User Agents that support (recognize) the name of a required constraint but cannot satisfy it will generate an error, while User Agents that do not support the constrainable property will not generate an error.

The following examples may help to understand how constraints work. The first shows a basic Constraint structure. Three constraints are given, each of which the User Agent will attempt to satisfy individually. Depending upon the resolutions available for this camera, it is possible that not all three constraints can be satisfied at the same time. If so, the User Agent will satisfy two if it can, or only one if not even two constraints can be satisfied together. Note that if not all three can be satisfied simultaneously, it is possible that there is more than one combination of two constraints that could be satisfied. If so, the User Agent will choose.

EXAMPLE 1

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.aspectRatio) {
  // Treat like an error.
}
const constraints = {
  width: 1280,
  height: 720,
  aspectRatio: 3/2
};
```

This next example adds a small bit of complexity. The ideal values are still given for width and height, but this time with minimum requirements on each as well as a minimum frameRate that must be satisfied. If it cannot satisfy the frameRate, width or height minimum it will reject the promise. Otherwise, it will try to satisfy the width, height, and aspectRatio target values as well and then resolve the promise.

EXAMPLE 2

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.aspectRatio || !supports.frameRate) {
  // Treat like an error.
}
const constraints = {
  frameRate: {min: 20},
  width: {min: 640, ideal: 1280},
  height: {min: 480, ideal: 720},
  aspectRatio: 3/2
};
```

This example illustrates the full control possible with the Constraints structure by adding the 'advanced' property. In this case, the User Agent behaves the same way with respect to the required constraints, but before attempting to satisfy the ideal values it will process the 'advanced' list. In this example the 'advanced' list contains two ConstraintSets. The first specifies width and height constraints, and the second specifies an aspectRatio constraint. Note that in the advanced list, these bare values are treated as 'exact' values. This example represents the following: "I need my video to be at least 640 pixels wide and at least 480 pixels high. My preference is for precisely 1920x1280, but if you can't give me that, give me an aspectRatio of 4x3 if at all possible. If even that is not possible, give me a resolution as close to 1280x720 as possible."

EXAMPLE 3

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.width || !supports.height) {
  // Treat like an error.
}
const constraints = {
  width: {min: 640, ideal: 1280},
  height: {min: 480, ideal: 720},
  advanced: [
    {width: 1920, height: 1280},
    {aspectRatio: 4/3}
  ]
};
```

The ordering of advanced ConstraintSets is significant. In the preceding example it is impossible to satisfy both the 1920x1280 ConstraintSet and the 4x3 aspect ratio ConstraintSet at the same time. Since the 1920x1280 occurs first in the list, the User Agent will attempt to satisfy it first. Application authors can therefore implement a backoff strategy by specifying multiple advanced ConstraintSets for the same property. For example, an application might specify three advanced ConstraintSets, the first asking for a frame rate greater than 500, the second asking for a frame rate greater than 400, and the third asking for one greater than 300. If the User Agent is capable of setting a frame rate greater than 500, it will (and the subsequent two ConstraintSets will be trivially satisfied). However, if the User Agent cannot set the frame rate above 500, it will skip that ConstraintSet and attempt to set the frame rate above 400. If that fails, it will then try to set it above 300. If the User Agent cannot satisfy any of the three ConstraintSets, it will set the frame rate to any value it can get. If the developers wanted to insist on 300 as a lower bound, they could provide that as a 'min' value in the basic ConstraintSet. In that case, the User Agent would fail altogether if it couldn't get a value over 300, but would choose a value over 500 if possible, then try for a value over 400.

Note that, unlike basic constraints, the constraints within a ConstraintSet in the advanced list must be satisfied together or skipped together. Thus, {width: 1920, height: 1280} is a request for that specific resolution, not a request for that width or that height. One can think of the basic constraints as requesting an 'or' (non-exclusive) of the individual constraints, while each advanced ConstraintSet is requesting an 'and' of the individual constraints in the ConstraintSet. An application may inspect the full set of Constraints currently in effect via the `getConstraints()` accessor.

The specific value that the User Agent chooses for a constrainable property is referred to as a Setting. For example, if the application applies a ConstraintSet specifying that the frameRate must be at least 30 frames per second, and no greater than 40, the Setting can be any intermediate value, e.g., 32, 35, or 37 frames per second. The application can query the current settings of the object's constrainable properties via the `getSettings()` accessor.

11.1 Interface Definition §

Although this specification formally defines **`ConstrainablePattern`** as a WebIDL interface, it is actually a template or pattern for other interfaces and cannot be inherited directly since the return values of the methods need to be extended, something WebIDL cannot do. Thus, each interface that wishes to make use of the functionality defined here will have to provide its own copy of the WebIDL for the functions and interfaces given here. However it can refer to the semantics defined here, which will not change. See MediaStreamTrack Interface Definition for an example of this.

This pattern relies on the constrainable object defining three internal slots:

1. A **[[Capabilities]]** internal slot, initialized to a `Capabilities` dictionary describing the aggregate allowable values for each constrainable property exposed, as explained under Capabilities, or an empty dictionary if it has none.

2. A **[[Constraints]]** internal slot, initialized to an empty `Constraints` dictionary.

3. A **[[Settings]]** internal slot, initialized to a `Settings` dictionary describing the currently active settings values for each constrainable property exposed, as explained under Settings, or an empty dictionary if it has none.

Template:

WebIDL

```
[Exposed=Window]
interface ConstrainablePattern {
  Capabilities   getCapabilities();
  Constraints    getConstraints();
  Settings       getSettings();
  Promise<undefined> applyConstraints(optional Constraints constraints =
{});
};
```

Methods §

getCapabilities

The `getCapabilities()` method returns the dictionary of the names of the constrainable properties that the object supports. When invoked, the User Agent *MUST* return the value of the [[Capabilities]] internal slot.

> ***NOTE***
> ***It is possible that the underlying hardware may not exactly map to the range defined for the constrainable property. Where this is possible, the entry* SHOULD *define how to translate and scale the hardware's setting onto the values defined for the property. For example, suppose that a hypothetical fluxCapacitance property ranges from -10 (min) to 10 (max), but there are common hardware devices that support only values of "off" "medium" and "full". The constrainable property definition might specify that for such hardware, the User Agent should map the range value of -10 to "off", 10 to "full", and 0 to "medium". It might also indicate that given a ConstraintSet imposing a strict value of 3, the User Agent should attempt to set the value of "medium" on the hardware, and that `getSettings()` should return a fluxCapacitance of 0, since that is the value defined as corresponding to "medium".***

`getConstraints`

The `getConstraints()` method returns the Constraints that were the argument to the most recent successful invocation of the ApplyConstraints algorithm on the object, maintaining the order in which they were specified. Note that some of the advanced ConstraintSets returned may not be currently satisfied. To check which ConstraintSets are currently in effect, the application should use `getSettings`. Instead of returning the exact constraints as described above, the UA *MAY* return a constraint set that has the identical effect in all situations as the applied constraints. When invoked, the User Agent *MUST* return the value of the [[Constraints]] internal slot.

getSettings

The **`getSettings()`** method returns the current settings of all the constrainable properties of the object, whether they are platform defaults or have been set by the ApplyConstraints algorithm. Note that a setting is a target value that complies with constraints, and therefore may differ from measured performance at times. When invoked, the User Agent *MUST* return the value of the [[Settings]] internal slot.

applyConstraints

When the **applyConstraints template method** is invoked, the User Agent *MUST* run the following steps:

1. Let *object* be the object on which this method was invoked.
2. Let *newConstraints* be the argument to this method.
3. Let *p* be a new promise.
4. Run the following steps in parallel, maintaining the order of invocations if this method is called multiple times:
    1. Let *failedConstraint* be the result of running the ApplyConstraints algorithm with *newConstraints* as the argument.
    2. Let *successfulSettings* be the *object*'s current settings after the algorithm in the above step has finished.
    3. Queue a task that runs the following steps:
        1. If *failedConstraint* is not `undefined`, let *message* be either `undefined` or an informative human-readable message, reject *p* with a new `OverconstrainedError` created by calling `OverconstrainedError(failedConstraint, message)`, and abort these steps. The existing constraints remain in effect in this case.
        2. Set *object*'s [[Constraints]] internal slot to *newConstraints* or a `Constraints` dictionary that has the identical effect in all situations as *newConstraints*.

3. Set *object*'s [[Settings]] internal slot to *successfulSettings*.
4. resolve *p* with `undefined`.

5. Return *p*.

The ApplyConstraints algorithm for applying constraints is stated below. Here are some preliminary definitions that are used in the statement of the algorithm:

We use the term **settings dictionary** for the set of values that might be applied as settings to the object.

For string valued constraints, we define "==" below to be true if one of the values in the sequence is exactly the same as the value being compared against.

We define the **fitness distance** between a settings dictionary and a constraint set *CS* as the sum, for each member (represented by a *constraintName* and *constraintValue* pair) which exists in *CS*, of the following values:

1. If *constraintName* is not supported by the User Agent, the fitness distance is 0.
2. If the constraint is **required** (*constraintValue* either contains one or more members named 'min', 'max', or 'exact', or is itself a bare value and bare values are to be treated as 'exact'), and the settings dictionary's value for the constraint does not satisfy the constraint, the fitness distance is positive infinity.
3. If the constraint is not required, and does not apply for this type of device, the fitness distance is 0 (that is, the constraint does not influence the fitness distance).
4. If no ideal value is specified (*constraintValue* either contains no member named 'ideal', or, if bare values are to be treated as 'ideal', isn't a bare value), the fitness distance is 0.
5. For all positive numeric constraints (such as height, width, frameRate, aspectRatio, sampleRate and sampleSize), the fitness distance is the result of the formula

```
(actual == ideal) ? 0 : |actual - ideal| / max(|actual|, |ideal|)
```

6. For all string, enum and boolean constraints (e.g. deviceId, groupId, facingMode, resizeMode, echoCancellation), the fitness distance is the result of the formula

```
(actual == ideal) ? 0 : 1
```

More definitions:

- We refer to each element of a ConstraintSet (other than the special term 'advanced') as a 'constraint' since it is intended to constrain the acceptable settings for the given property from the full list or range given in the corresponding Capability of the ConstrainablePattern object to a value that is within the range or list of values it specifies.
- We refer to the "effective Capability" C of an object O as the possibly proper subset of the possible values of C (as returned by getCapabilities) taking into consideration environmental limitations and/or restrictions placed by other constraints. For example given a ConstraintSet that constrains the aspectRatio, height, and width properties, the values assigned to any two of the properties limit the effective Capability of the third. The set of effective Capabilities may be platform dependent. For example, on a resource-limited device it may not be possible to set properties P1 and P2 both to 'high', while on another less limited device, this may be possible.
- A settings dictionary, which is a set of values for the constrainable properties of an object O, satisfies ConstraintSet CS if the fitness distance between the set and CS is less than infinity.
- A set of ConstraintSets CS1...CSn (n >= 1) can be satisfied by an object O if it is possible to find a settings dictionary of O that satisfies CS1...CSn simultaneously.
- To apply a set of ConstraintSets CS1...CSn to object O is to choose such a sequence of values that satisfy CS1...CSn and assign them as the settings for the properties of O.

We define the **SelectSettings** algorithm as follows:

1. Each constraint specifies one or more values (or a range of values) for its property. A property *MAY* appear more than once in the list of 'advanced' ConstraintSets. If an empty list has been given as the value for a constraint, it *MUST* be interpreted as if the constraint were not specified (in other words, an empty constraint == no constraint).

   Note that unknown properties are discarded by WebIDL, which means that unknown/unsupported required constraints will silently disappear. To avoid this being a surprise, application authors are expected to first use the `getSupportedConstraints()` method as shown in the Examples below.

2. Let *object* be the `ConstrainablePattern` object on which this algorithm is applied. Let *copy* be an unconstrained copy of *object* (i.e., *copy* should behave as if it were *object* with all ConstraintSets removed.)
3. For every possible settings dictionary of *copy* compute its fitness distance, treating bare values of properties as ideal values. Let *candidates* be the set of settings dictionaries for which the fitness distance is finite.
4. If *candidates* is empty, return `undefined` as the result of the SelectSettings algorithm.

5. Iterate over the 'advanced' ConstraintSets in *newConstraints* in the order in which they were specified. For each ConstraintSet:
    1. compute the fitness distance between it and each settings dictionary in *candidates*, treating bare values of properties as exact.
    2. If the fitness distance is finite for one or more settings dictionaries in *candidates*, keep those settings dictionaries in *candidates*, discarding others.

       If the fitness distance is infinite for all settings dictionaries in *candidates*, ignore this ConstraintSet.
6. Select one settings dictionary from *candidates*, and return it as the result of the SelectSettings algorithm. The UA *SHOULD* use the one with the smallest fitness distance, as calculated in step 3, but *MAY* prefer ones with resizeMode set to `"none"` over `"crop-and-scale"`.

To apply the **ApplyConstraints algorithm** to an *object*, given *newConstraints* as an argument, the User Agent *MUST* run the following steps:

1. Let *successfulSettings* be the result of running the SelectSettings algorithm with *newConstraints* as the constraint set.
2. If *successfulSettings* is `undefined`, let *failedConstraint* be any required constraint whose fitness distance was infinity for all settings dictionaries examined while executing the SelectSettings algorithm, or `""` if there isn't one, and then return *failedConstraint* and abort these steps.
3. In a single operation, remove the existing constraints from *object*, apply *newConstraints*, and apply *successfulSettings* as the current settings.
4. Return `undefined`.

NOTE

Any implementation that has the same result as the algorithm above is an allowed implementation. For instance, the implementation may choose to keep track of the maximum and minimum values for a setting that are OK under the constraints considered, rather than keeping track of all possible values for the setting.

> **NOTE**
> ***When picking a settings dictionary, the UA can use any information available to it. Examples of such information may be whether the selection is done as part of device selection in getUserMedia, whether the energy usage of the camera varies between the settings dictionaries, or whether using a settings dictionary will cause the device driver to apply resampling.***

The User Agent *MAY* choose new settings for the constrainable properties of the object at any time. When it does so it *MUST* attempt to satisfy all current Constraints, in the manner described in the algorithm above, let *successfulSettings* be the resulting new settings, and queue a task to run the following steps:

1. Let *object* be the `ConstrainablePattern` object on which new settings for one or more constrainable properties have changed.

2. Set *object*'s [[Settings]] internal slot to *successfulSettings*.

An example of Constraints that could be passed into `applyConstraints()` or returned as a value of `constraints` is below. It uses the constrainable properties defined for `MediaStreamTrack`.

EXAMPLE 4

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.facingMode) {
  // Treat like an error.
}
const constraints = {
  width: {min: 640},
  height: {min: 480},
  advanced: [
    {width: 650},
    {width: {min: 650}},
    {frameRate: 60},
    {width: {max: 800}},
    {facingMode: 'user'}
  ]
};
```

Here is another example, specifically for a video track where I must have a particular camera and have separate preferences for the width and height:

EXAMPLE 5

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.deviceId) {
  // Treat like an error.
}
const constraints = {
  deviceId: {exact: '20983-20o198-109283-098-09812'},
  advanced: [
    {width: {min: 800, max: 1200}},
    {height: {min: 600}}
  ]
};
```

And here's one for an audio track:

EXAMPLE 6

```
const supports = navigator.mediaDevices.getSupportedConstraints();
if (!supports.deviceId || !supports.channelCount) {
  // Treat like an error.
}
const constraints = {
  advanced: [
    {deviceId: '64815-wi3c89-1839dk-x82-392aa'},
    {channelCount: 2}
  ]
};
```

Here's an example of use of ideal:

EXAMPLE 7

```
async function useIdeal() {
  const supports = navigator.mediaDevices.getSupportedConstraints();
  if (!supports.aspectRatio || !supports.facingMode) {
    // Treat like an error.
  }
  const stream = await navigator.mediaDevices.getUserMedia({
    video: {
      width: {min: 320, ideal: 1280, max: 1920},
      height: {min: 240, ideal: 720, max: 1080},
      frameRate: 30, // Shorthand for ideal.
      facingMode: {
        exact: 'environment'
        // facingMode: "environment" would be optional.
      }
    }
  });
}
```

Here's an example of "I want 720p, but I can accept up to 1080p and down to VGA.":

EXAMPLE 8

```
async function constrainVideo() {
  const supports = navigator.mediaDevices.getSupportedConstraints();
  if (!supports.width || !supports.height) {
    // Treat like an error.
  }
  const stream = await navigator.mediaDevices.getUserMedia({
    video: {
      width: {min: 640, ideal: 1280, max: 1920},
      height: {min: 480, ideal: 720, max: 1080},
    }
  });
}
```

Here's an example of "I want a front-facing camera and it must be VGA.":

EXAMPLE 9

```
async function specifyCamera() {
  const supports = navigator.mediaDevices.getSupportedConstraints();
  if (!supports.width || !supports.height || !supports.facingMode) {
    // Treat like an error.
  }
  const stream = await navigator.mediaDevices.getUserMedia({
    video: {
      facingMode: {exact: 'user'},
      width: {exact: 640},
      height: {exact: 480}
    }
  });
}
```

11.2 Types for Constrainable Properties §

The syntax for the specification of the set of legal values depends on the type of the values. In addition to the standard atomic types (boolean, long, double, DOMString), legal values include lists of any of the atomic types, plus min-max ranges, as defined below.

List values *MUST* be interpreted as disjunctions. For example, if a property 'facingMode' for a camera is defined as having legal values ["left", "right", "user", "environment"], this means that 'facingMode' can have the values "left", "right", "environment", and "user". Similarly `Constraints` restricting 'facingMode' to ["user", "left", "right"] would mean that the User Agent should select a camera (or point the camera, if that is possible) so that "facingMode" is either "user", "left", or "right". This Constraint would thus request that the camera not be facing away from the user, but would allow the User Agent to allow the user to choose other directions.

WebIDL

```
dictionary DoubleRange {
  double max;
  double min;
};
```

Dictionary `DoubleRange` Members §

`max` **of type** `double`
: The maximum legal value of this property.

`min` **of type** `double`
: The minimum value of this Property.

WebIDL

```
dictionary ConstrainDoubleRange : DoubleRange {
  double exact;
  double ideal;
};
```

Dictionary `ConstrainDoubleRange` Members §

`exact` **of type** `double`
: The exact required value for this property.

`ideal` **of type** `double`
: The ideal (target) value for this property.

WebIDL

```
dictionary ULongRange {
  [Clamp] unsigned long max;
  [Clamp] unsigned long min;
};
```

Dictionary `ULongRange` Members §

`max` **of type** `unsigned long`
: The maximum legal value of this property.

`min` **of type** `unsigned long`
: The minimum value of this property.

WebIDL

```
dictionary ConstrainULongRange : ULongRange {
  [Clamp] unsigned long exact;
  [Clamp] unsigned long ideal;
};
```

Dictionary ConstrainULongRange Members §

exact **of type** unsigned long
: The exact required value for this property.

ideal **of type** unsigned long
: The ideal (target) value for this property.

WebIDL

```
dictionary ConstrainBooleanParameters {
  boolean exact;
  boolean ideal;
};
```

Dictionary ConstrainBooleanParameters Members §

exact **of type** boolean
: The exact required value for this property.

ideal **of type** boolean
: The ideal (target) value for this property.

WebIDL

```
dictionary ConstrainDOMStringParameters {
  (DOMString or sequence<DOMString>) exact;
  (DOMString or sequence<DOMString>) ideal;
};
```

Dictionary ConstrainDOMStringParameters Members §

exact **of type** (DOMString or sequence<DOMString>)
: The exact required value for this property.

ideal **of type** (DOMString or sequence<DOMString>)

The ideal (target) value for this property.

WebIDL

```
typedef ([Clamp] unsigned long or ConstrainULongRange) ConstrainULong;
```

Throughout this specification, the identifier **ConstrainULong** is used to refer to the ([Clamp] unsigned long or ConstrainULongRange) type.

WebIDL

```
typedef (double or ConstrainDoubleRange) ConstrainDouble;
```

Throughout this specification, the identifier **ConstrainDouble** is used to refer to the (double or ConstrainDoubleRange) type.

WebIDL

```
typedef (boolean or ConstrainBooleanParameters) ConstrainBoolean;
```

Throughout this specification, the identifier **ConstrainBoolean** is used to refer to the (boolean or ConstrainBooleanParameters) type.

WebIDL

```
typedef (DOMString or
         sequence<DOMString> or
         ConstrainDOMStringParameters) ConstrainDOMString;
```

Throughout this specification, the identifier **ConstrainDOMString** is used to refer to the (DOMString or sequence<DOMString> or ConstrainDOMStringParameters) type.

11.3 Capabilities §

Capabilities is a dictionary containing one or more key-value pairs, where each key *MUST* be a constrainable property, and each value *MUST* be a subset of the set of values allowed for that property. The exact syntax of the value expression depends on the type of the property. The Capabilities dictionary specifies which constrainable properties that can be applied, as constraints, to the constrainable object. Note that the Capabilities of a constrainable object *MAY* be a subset of the properties defined in the Web platform, with a subset of the set values for those properties. Note that Capabilities are returned from the User Agent to the application, and cannot be specified by the application. However, the application can control the Settings that the User Agent chooses for constrainable properties by means of Constraints.

An example of a Capabilities dictionary is shown below. In this case, the constrainable object is a video source with a very limited set of Capabilities.

EXAMPLE 10

```
{
  frameRate: {min: 1.0, max: 60.0},
  facingMode: ['user', 'left']
}
```

The next example below points out that capabilities for range values provide ranges for individual constrainable properties, not combinations. This is particularly relevant for video width and height, since the ranges for width and height are reported separately. In the example, if the constrainable object can only provide 640x480 and 800x600 resolutions the relevant capabilities returned would be:

EXAMPLE 11

```
{
  width: {min: 640, max: 800},
  height: {min: 480, max: 600},
  aspectRatio: 4/3
}
```

Note in the example above that the aspectRatio would make clear that arbitrary combination of widths and heights are not possible, although it would still suggest that more than two resolutions were available.

A specification using the Constrainable Pattern should not subclass the below dictionary, but instead provide its own definition. See `MediaTrackCapabilities` for an example.

WebIDL

```
dictionary Capabilities {};
```

11.4 Settings §

`Settings` is a dictionary containing one or more key-value pairs. It *MUST* contain each key returned in `getCapabilities()` for which the property is defined on the object type it's returned on; for instance, an audio `MediaStreamTrack` has no "width" property. There *MUST* be a single value for each key and the value *MUST* be a member of the set defined for that property by `getCapabilities()`. The `Settings` dictionary contains the actual values that the User Agent has chosen for the object's constrainable properties. The exact syntax of the value depends on the type of the property.

A conforming User Agent *MUST* support all the constrainable properties defined in this specification.

An example of a Settings dictionary is shown below. This example is not very realistic in that a User Agent would actually be required to support more constrainable properties than just these.

EXAMPLE 12

```
{
  frameRate: 30.0,
  facingMode: 'user'
}
```

A specification using the Constrainable Pattern should not subclass the below dictionary, but instead provide its own definition. See `MediaTrackSettings` for an example.

WebIDL

```
dictionary Settings {};
```

11.5 Constraints and ConstraintSet §

Due to the limitations of WebIDL, interfaces implementing the Constrainable Pattern cannot simply subclass Constraints and ConstraintSet as they are defined here. Instead they must provide their own definitions that follow this pattern. See MediaTrackConstraints for an example of this.

WebIDL

```
dictionary ConstraintSet {};
```

Each member of a `ConstraintSet` corresponds to a constrainable property and specifies a subset of the property's legal Capability values. Applying a ConstraintSet instructs the User Agent to restrict the settings of the corresponding constrainable properties to the specified values or ranges of values. A given property *MAY* occur both in the basic Constraints set and in the advanced ConstraintSets list, and *MAY* occur at most once in each ConstraintSet in the advanced list.

WebIDL

```
dictionary Constraints : ConstraintSet {
  sequence<ConstraintSet> advanced;
};
```

Dictionary `Constraints` Members §

`advanced` **of type sequence<`ConstraintSet`>**

This is the list of ConstraintSets that the User Agent *MUST* attempt to satisfy, in order, skipping only those that cannot be satisfied. The order of these ConstraintSets is significant. In particular, when they are passed as an argument to `applyConstraints`, the User Agent *MUST* try to satisfy them in the order that is specified. Thus if advanced ConstraintSets C1 and C2 can be satisfied individually, but not together, then whichever of C1 and C2 is first in this list will be satisfied, and the other will not. The User Agent *MUST* attempt to satisfy all ConstraintSets in the list, even if some cannot be satisfied. Thus, in the preceding example, if constraint C3 is specified after C1 and C2, the User Agent will attempt to satisfy C3 even though C2 cannot be satisfied. Note that a given property name may occur only once in each ConstraintSet but may occur in more than one ConstraintSet.

12. Examples §

This sample code exposes a button. When clicked, the button is disabled and the user is prompted to offer a stream. The user can cause the button to be re-enabled by providing a stream (e.g., giving the page access to the local camera) and then disabling the stream (e.g., revoking that access).

EXAMPLE 13

```
<button id="startBtn">Start</button>
<script>
const startBtn = document.getElementById('startBtn');

startBtn.onclick = async () => {
  try {
    startBtn.disabled = true;
    const constraints = {
      audio: true,
      video: true
    };

    const stream = await navigator.mediaDevices.getUserMedia(constraints);

    for (let track of stream.getTracks()) {
      track.onended = () => {
        startBtn.disabled = stream.getTracks().some((t) => t.readyState ==
'live');
      };
    }
  } catch (err) {
    console.error(err);
  }
};
</script>
```

This example allows people to take photos of themselves from the local video camera. Note that the Image Capture specification [image-capture] provides a simpler way to accomplish this.

EXAMPLE 14

```
<script>
window.onload = async () => {
  const video = document.getElementById('monitor');
  const canvas = document.getElementById('photo');
  const shutter = document.getElementById('shutter');

  try {
    video.srcObject = await navigator.mediaDevices.getUserMedia({video:
true});

    await new Promise((resolve) => video.onloadedmetadata = resolve);
    canvas.width = video.videoWidth;
    canvas.height = video.videoHeight;
    document.getElementById('splash').hidden = true;
    document.getElementById('app').hidden = false;

    shutter.onclick = () => canvas.getContext('2d').drawImage(video, 0,
0);
  } catch (err) {
    console.error(err);
  }
};
</script>

<h1>Snapshot Kiosk</h1>

<section id="splash">
  <p id="errorMessage">Loading...</p>
</section>

<section id="app" hidden>
  <video id="monitor" autoplay></video>
  <button id="shutter">&#x1F4F7;</button>
  <canvas id="photo"></canvas>
</section>
```

13. Permissions Policy Integration §

This specification defines two policy-controlled features identified by the strings `"camera"` and `"microphone"`. Both have a default allowlist of `"self"`.

> ***NOTE***
> ***A document's permissions policy determines whether any content in that document is allowed to use `getUserMedia` to request camera or microphone respectively. If disabled in any document, no content in the document will be allowed to use `getUserMedia` to request the camera or microphone respectively. This is enforced by the request permission to use algorithm.***
>
> ***Additionally, `enumerateDevices` will only enumerate devices the document is allowed to use.***

14. Privacy Indicator Requirements §

For each *kind* of device that `getUserMedia()` exposes,

- Define *any<kind>Accessible* (e.g. *anyAudioAccessible*, *anyVideoAccessible*) as the logical OR of the [[kindsAccessibleMap]]*[kind]* value and all the [[devicesAccessibleMap]]*[deviceId]* values for devices of that kind.
- Define any*<kind>Live* (e.g. *anyAudioLive*, *anyVideoLive*) to be the logical OR of the [[kindsAccessibleMap]]*[kind]* value and all the [[devicesLiveMap]]*[deviceId]* values for devices of that kind.

Define *anyAccessible* to be the logical OR of all *any<kind>Accessible* values.

Define *anyLive* to be the logical OR of all *any<kind>Live* values.

Then the following are requirements on the User Agent:

- The User Agent *MUST* indicate to the user when the value of *anyAccessible* changes.
- The User Agent *MUST* indicate to the user when the value of *anyLive* changes.
- If the User Agent provides indication to the user per *kind*, then for each *any<kind>Accessible* value and *any<kind>Live* value, it *MUST* at minimum indicate when the value changes.
- If the User Agent provides indication to the user per *device*, then for each [[devicesAccessibleMap]]*[deviceId]* value and [[devicesLiveMap]]*[deviceId]* value, it *MUST* at minimum indicate when the value changes.
- Any false-to-true transition indicated *MUST* remain observable for a sufficient time that a

reasonably-observant user could become aware of it. This *SHOULD* be at least 3 seconds.

- Any of the above transition indications *MAY* be combined as long as the combined indication cannot transition to false if any of its component indications are still true.

and the following are encouraged behaviors for the User Agent:

- The User Agent is encouraged to provide ongoing indication of the current state of *anyAccessible*.
- The User Agent is encouraged to provide ongoing indication of the current state of *anyLive* and to make any generic hardware device indicator light match.
- If the User Agent provides indication to the user per *kind*, then for each any*<kind>Accessible* value and any*<kind>Live* value, it is encouraged to provide ongoing indication of the current state of the value. It is also encouraged to make any device-type-specific hardware indicator light match the corresponding any*<kind>Live* value.
- If the User Agent provides indication to the user per *device*, then for each [[devicesAccessibleMap]]*[deviceId]* value and [[devicesLiveMap]]*[deviceId]* value, it is encouraged to provide ongoing indication of the current state of the value. It is also encouraged to make any device-specific hardware indicator light match the corresponding [[devicesLiveMap]]*[deviceId]* value.
- Any of the above ongoing indications *MAY* be used instead of the corresponding required transition indication provided the false-to-true transition requirement is met.

15. Privacy and Security Considerations §

This section is non-normative; it specifies no new behavior, but instead summarizes information already present in other parts of the specification.

This document extends the Web platform with the ability to manage input devices for media - in this iteration, microphones, and cameras. It also allows the manipulation of audio output devices (speakers and headphones). Capturing audio and video exposes personally-identifiable information to applications, and this specification requires obtaining explicit user consent before sharing it.

Without authorization (to the "drive-by web"), it offers the ability to tell how many devices there are of each class, and how they are grouped together (e.g. a microphone and camera belonging to a single Web cam). The identifiers for the devices are designed to not be useful for a fingerprint that can track the user between origins, but the number and grouping of devices adds to the fingerprint surface. It recommends to treat the per-origin persistent identifier `deviceId` as other persistent storage (e.g. cookies) are treated.

When authorization is given, this document describes how to get access to, and use, media data from the devices mentioned. This data may be sensitive; advice is given that indicators should be supplied to indicate that devices are in use, but both the nature of authorization and the indicators of in-use devices are platform decisions.

Authorization may be given on a case-by-case basis, or be persistent. In the case of a case-by-case authorization, it is important that the user be able to say "no" in a way that prevents the UI from blocking user interaction until permission is given - either by offering a way to say a "persistent NO" or by not using a modal permissions dialog.

When authorization to any media device is given, application developers gain access to the labels of all available media capture devices. In most cases, the labels are persistent across browsing sessions and across origins that have also been granted authorization, and thus potentially provide a way to track a given device across time and origins.

For origins to which permission has been granted, the devicechange event will be emitted across browsing contexts and origins each time a new media device is added or removed; user agents can mitigate the risk of correlation of browsing activity across origins by fuzzing the timing of these events.

Once a developer gains access to a media stream from a capture device, the developer also gains access to detailed information about the device, including its range of operating capabilities (e.g. available resolutions for a camera). These operating capabilities are for the most part persistent across browsing sessions and origins, and thus provide a way to track a given device across time and origins.

Once access to a video stream from a capture device is obtained, that stream can most likely be used to fingerprint uniquely the said device (e.g. via dead pixel detection). Similarly, once access to an audio stream is obtained, that stream can most likely be used to fingerprint user location down to the level of a room or even simultaneous occupation of a room by disparate users (e.g. via analysis of ambient audio or of unique audio purposely played out of the device speaker). User-level mitigation for both audio and video consists of covering up the camera and/or microphone or revoking permission via User Agent chrome controls.

It is possible to use constraints so that the failure of a getUserMedia call will return information about devices on the system without prompting the user, which increases the surface available for fingerprinting. The User Agent should consider limiting the rate at which failed getUserMedia calls are allowed in order to limit this additional surface.

In the case of persistent authorization via a stored permission, it is important that it is easy to find the list of granted permissions and revoke permissions that the user wishes to revoke.

Once permission has been granted, the User Agent should make two things readily apparent to the user:

- That the page has access to the devices for which permission is given
- Whether or not any of the devices are presently recording ("on air") indicator

NOTE
Developers of sites with stored permissions should be careful that these permissions not be abused. These permissions can be revoked using the [permissions] API.

In particular, they should not make it possible to automatically send audio or video streams from authorized media devices to an end point that a third party can select.

Indeed, if a site offered URLs such as `https://webrtc.example.org/?call=user` that would automatically set up calls and transmit audio/video to `user`, it would be open for instance to the following abuse:

Users who have granted stored permissions to `https://webrtc.example.org/` could be tricked to send their audio/video streams to an attacker `EvilSpy` by following a link or being redirected to `https://webrtc.example.org/?user=EvilSpy`.

16. Extensibility §

This section is non-normative.

Although new versions of this specification may be produced in the future, it is also expected that other standards will need to define new capabilities that build upon those in this specification. The purpose of this section is to provide guidance to creators of such extensions.

Any WebIDL-defined interfaces, methods, or attributes in the specification may be extended. Two likely extension points are defining a new media type and defining a new constrainable property.

16.1 Defining a new media type (beyond the existing Audio and Video types) §

At a minimum, defining a new media type would require

- adding a new getXXXXTracks() method for the type to the `MediaStream` interface,
- describing what a muted or disabled track of that type will render (see § 4.3.1 Life-cycle and Media Flow),
- adding the new type as an additional legal value for the `kind` attribute on the `MediaStreamTrack` interface,
- defining any constrainable properties (see § 4.3.8 Constrainable Properties) that are applicable to the media type,
- updating how the `HTMLMediaElement` works with a `MediaStream` containing a track of the new media type (see § 6. MediaStreams in Media Elements), including adding a corollary to audible/inaudible for the new media type,
- updating `MediaDeviceKind` if the new type has enumerable devices,
- updating the `getCapabilities()` and `getUserMedia()` descriptions,
- adding the new type to the `MediaStreamConstraints` dictionary,
- describing any new security and/or privacy considerations (see § 15. Privacy and Security Considerations) introduced by the new type, and
- if the new type requires user authorization, defining new permissions for it, including a new PermissionDescriptor name associated with the new `kind`, and defining how these permissions, along with access starting and ending, as well as muting/disabling, affect any new and/or existing "on-air" and "device accessible" indicator states (see MediaDevices).

Additionally, it should include updating

- the source definition,
- the list of media stream consumers,
- the description of the `label` attribute on the `MediaStreamTrack` interface,
- the list of sinks (see § 5. The model: sources, sinks, constraints, and settings), and
- the best practice statements referring to video and audio (see § 10.6 Implementation Suggestions).

It might also include

- explaining how the media is expected to be used by potential consumers, and
- giving examples in `MediaStreamTrackState` of how such a track might become ended.

16.2 Defining a new constrainable property §

This will require thinking through and defining how Constraints, Capabilities, and Settings for the property (see § 3. Terminology) will work. The relevant text in `MediaTrackSupportedConstraints`, `MediaTrackCapabilities`, `MediaTrackConstraints`, `MediaTrackSettings`, § 4.3.8 Constrainable Properties, and `MediaStreamConstraints` are the model to use.

Creators of extension specifications are strongly encouraged to notify the specification maintainers on the specification repository.
Future versions of this specification and others created by the WebRTC Working Group will take into consideration all extensions they are aware of in an attempt to reduce potential usage conflicts.

It is also likely that new consumers of `MediaStream`s or `MediaStreamTrack`s will be defined in the future. The following section provides guidance.

16.3 Defining new consumers of `MediaStream`s and `MediaStreamTrack`s §

At a minimum, any new consumer of a `MediaStreamTrack` will need to define

- how a `MediaStreamTrack` will render in the various states in which it can be, including muted and disabled (see § 4.3.1 Life-cycle and Media Flow).

A. Acknowledgements §

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