



Google
Developers



Web Page Design With The GPU in Mind

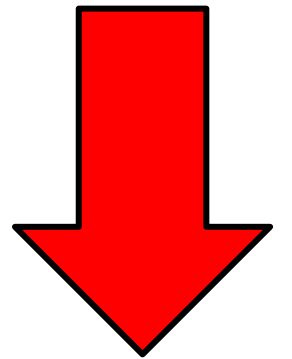
Supercharge your page rendering with the GPU

Grace Kloba

Tech Lead - Chrome for Android

Colt McAnlis

Developer Advocate -
Chrome



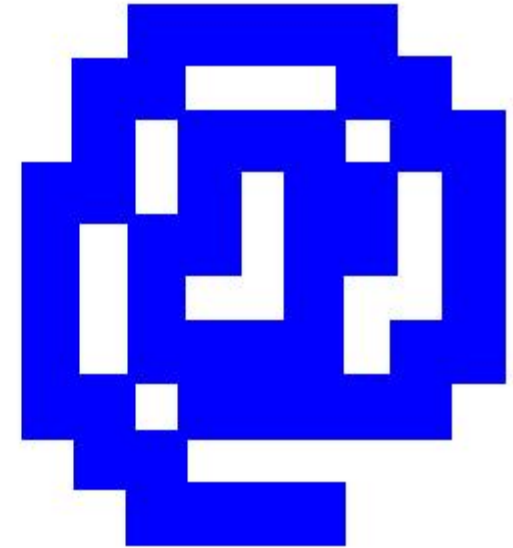
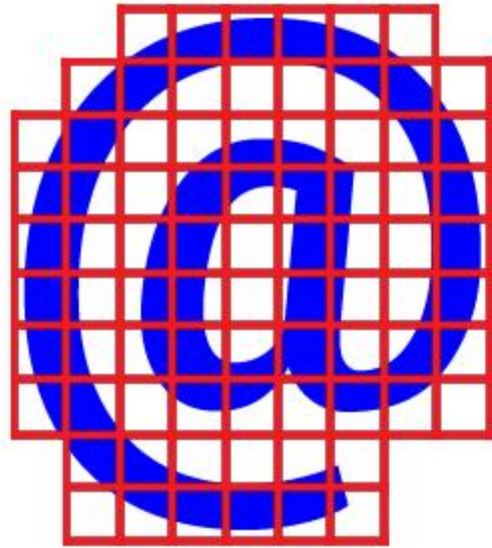
#perfmatters



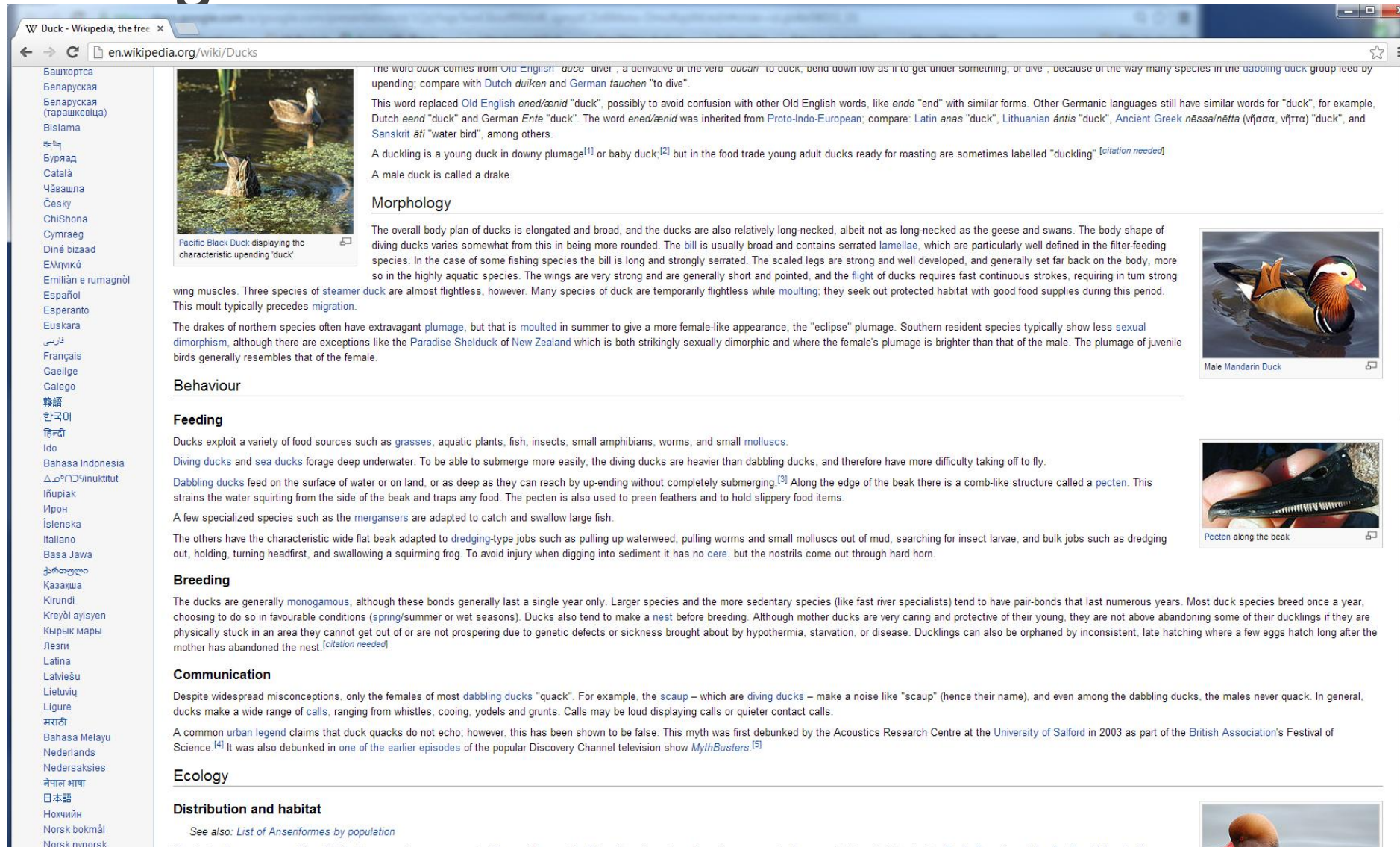
How does a **web page** get **drawn**?

More importantly, why hasn't it drawn my cat photos yet?

Software Rasterization

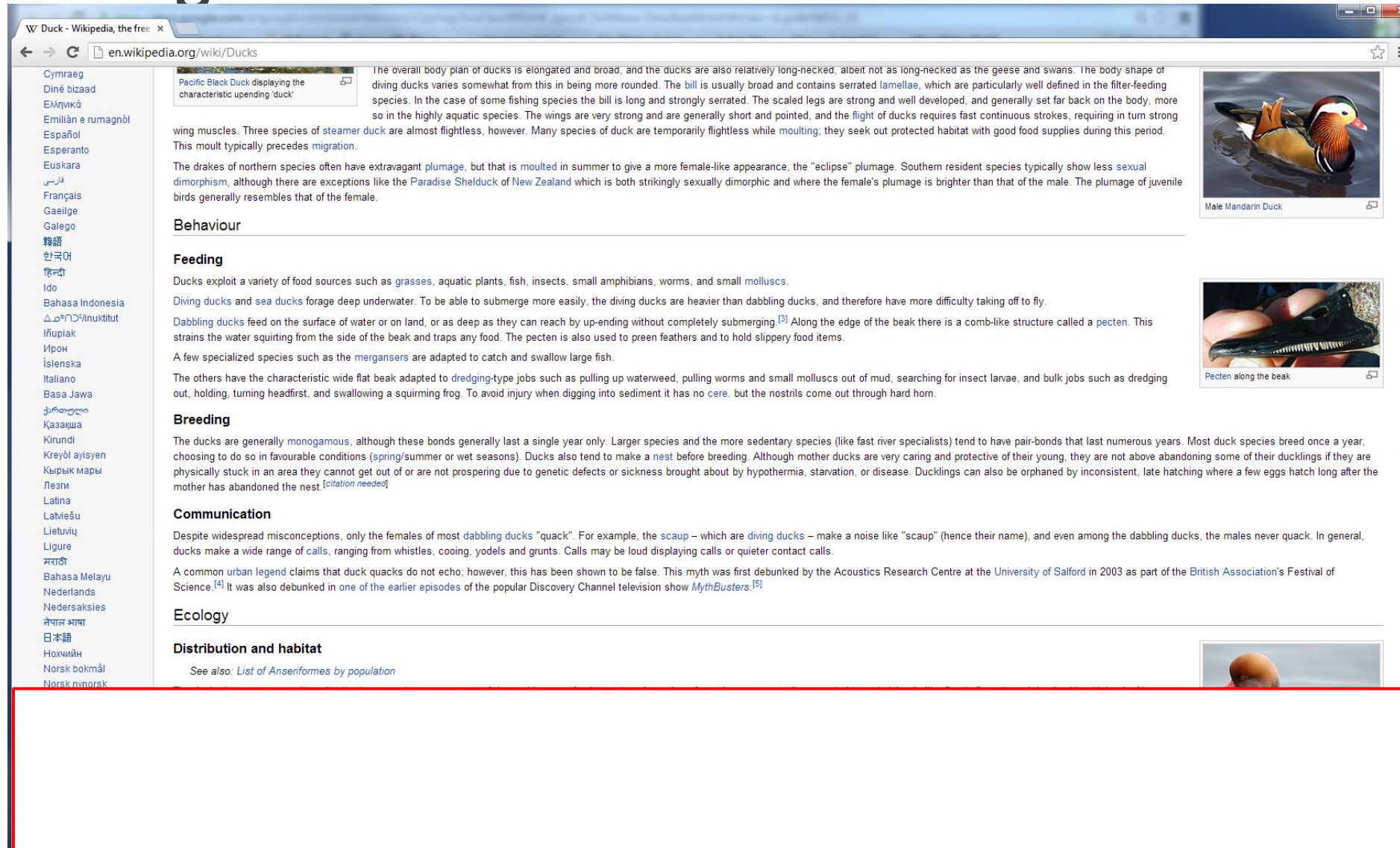


Scrolling & Rasterization



The screenshot shows a web browser window displaying the Wikipedia article for "Duck". The browser's address bar shows "en.wikipedia.org/wiki/Ducks". On the left side, there is a vertical language menu with various languages listed, including Russian, Ukrainian, Belarusian, and many others. The main content area of the article is visible, starting with the text: "The word *duck* comes from Old English *ƿoƿe* 'diver', a derivative of the verb *ƿocean* 'to duck, bend down low as if to get under something, or dive', because of the way many species in the dabbling duck group feed by upending; compare with Dutch *duiken* and German *tauchen* 'to dive'." Below this text is a small image of a Pacific Black Duck with the caption "Pacific Black Duck displaying the characteristic upending 'duck'". The article continues with sections on "Morphology", "Behaviour", "Feeding", "Breeding", "Communication", and "Ecology". There are also several images of ducks, including a Male Mandarin Duck and a close-up of a duck's beak showing the pecten. The browser window also shows standard navigation buttons like back, forward, and search.

Scrolling & Rasterization



The screenshot shows a web browser window displaying the Wikipedia article for "Duck". The browser's address bar shows "en.wikipedia.org/wiki/Ducks". The page content includes a table of contents, an introductory paragraph, and several sections: "Behaviour", "Feeding", "Breeding", "Communication", "Ecology", and "Distribution and habitat". There are three images: a Pacific Black Duck, a Male Mandarin Duck, and a close-up of a duck's beak showing the pecten. A red rectangular box is drawn over the bottom portion of the page, covering the "Distribution and habitat" section and the bottom of the browser window.

W Duck - Wikipedia, the free x

en.wikipedia.org/wiki/Ducks

Cymraeg
Diné bizaad
Ελληνικά
Emiliàn e rumagnòl
Español
Esperanto
Euskara
فارسی
Français
Gaelige
Galego
한국어
Հայերէս
Ido
Bahasa Indonesia
ጵብርታጵጥጥ
Írúipiak
Ирон
Íslenska
Italiano
Basa Jawa
Қазақша
Kisumu
Kreyòl ayisyen
Кырык мари
Лезги
Latina
Latinešu
Lietuvių
Ligure
मराठी
Bahasa Melayu
Nederlands
Nedersaksies
नेपाल भाषा
日本語
Нохчийн
Norsk bokmål
Norsk nynorsk

Pacific Black Duck displaying the characteristic upending 'duck'

The overall body plan of ducks is elongated and broad, and the ducks are also relatively long-necked, albeit not as long-necked as the geese and swans. The body shape of diving ducks varies somewhat from this in being more rounded. The bill is usually broad and contains serrated lamellae, which are particularly well defined in the filter-feeding species. In the case of some fishing species the bill is long and strongly serrated. The scaled legs are strong and well developed, and generally set far back on the body, more so in the highly aquatic species. The wings are very strong and are generally short and pointed, and the flight of ducks requires fast continuous strokes, requiring in turn strong wing muscles. Three species of steamer duck are almost flightless, however. Many species of duck are temporarily flightless while moulting; they seek out protected habitat with good food supplies during this period. This moult typically precedes migration.

The drakes of northern species often have extravagant plumage, but that is moulted in summer to give a more female-like appearance, the "eclipse" plumage. Southern resident species typically show less sexual dimorphism, although there are exceptions like the Paradise Shelduck of New Zealand which is both strikingly sexually dimorphic and where the female's plumage is brighter than that of the male. The plumage of juvenile birds generally resembles that of the female.

Behaviour

Feeding

Ducks exploit a variety of food sources such as *grasses*, aquatic plants, fish, insects, small amphibians, worms, and small molluscs.

Diving ducks and sea ducks forage deep underwater. To be able to submerge more easily, the diving ducks are heavier than dabbling ducks, and therefore have more difficulty taking off to fly.

Dabbling ducks feed on the surface of water or on land, or as deep as they can reach by up-ending without completely submerging.^[3] Along the edge of the beak there is a comb-like structure called a pecten. This strains the water squirting from the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items.

A few specialized species such as the mergansers are adapted to catch and swallow large fish.

The others have the characteristic wide flat beak adapted to dredging-type jobs such as pulling up waterweed, pulling worms and small molluscs out of mud, searching for insect larvae, and bulk jobs such as dredging out, holding, turning headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere, but the nostrils come out through hard horn.

Breeding

The ducks are generally monogamous, although these bonds generally last a single year only. Larger species and the more sedentary species (like fast river specialists) tend to have pair-bonds that last numerous years. Most duck species breed once a year, choosing to do so in favourable conditions (spring/summer or wet seasons). Ducks also tend to make a nest before breeding. Although mother ducks are very caring and protective of their young, they are not above abandoning some of their ducklings if they are physically stuck in an area they cannot get out of or are not prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by inconsistent, late hatching where a few eggs hatch long after the mother has abandoned the nest.^[citation needed]

Communication

Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from whistles, cooing, yodels and grunts. Calls may be loud displaying calls or quieter contact calls.

A common urban legend claims that duck quacks do not echo; however, this has been shown to be false. This myth was first debunked by the Acoustics Research Centre at the University of Salford in 2003 as part of the British Association's Festival of Science.^[4] It was also debunked in one of the earlier episodes of the popular Discovery Channel television show *MythBusters*.^[5]

Ecology

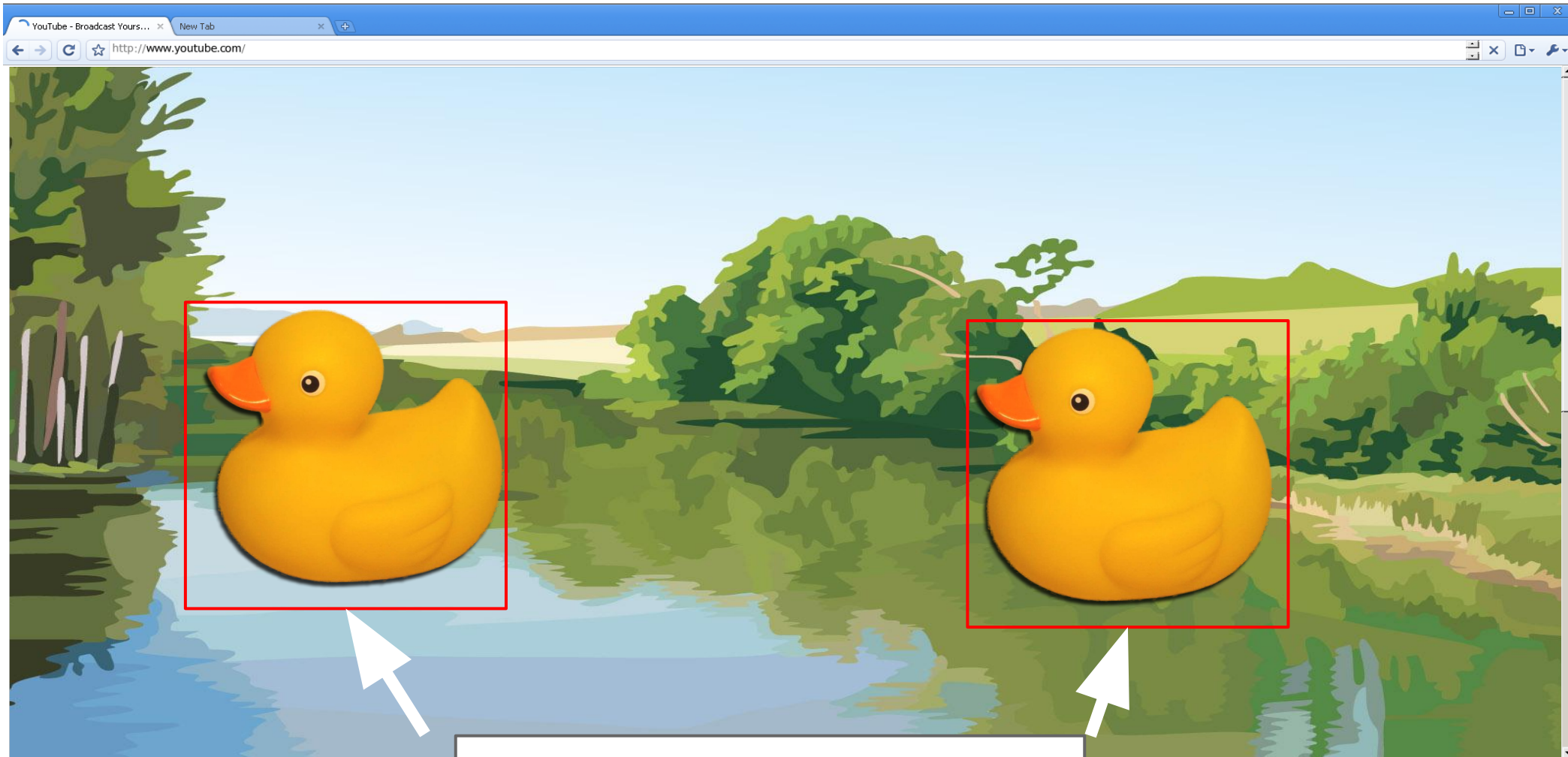
Distribution and habitat

See also: List of Anseriformes by population

Male Mandarin Duck

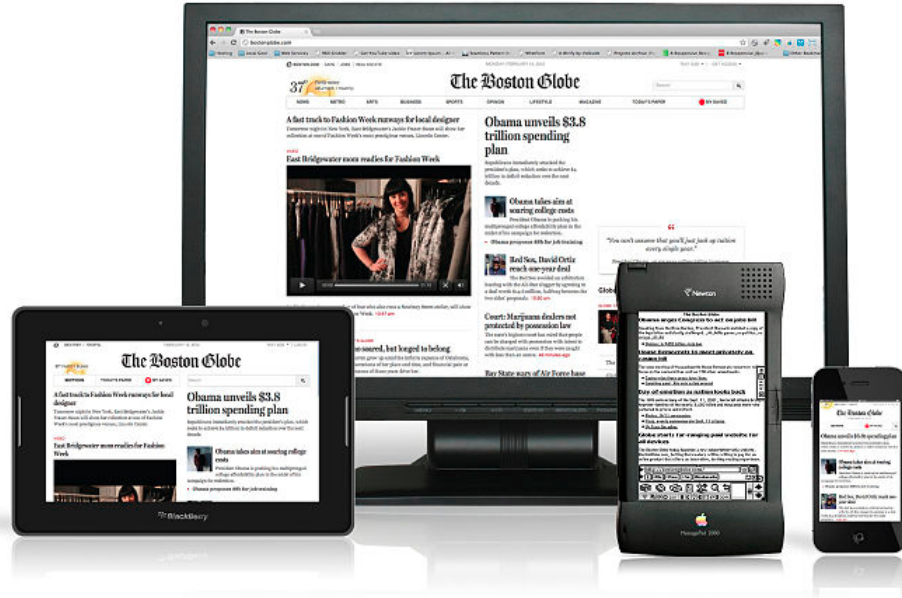
Pecten along the beak

Animation & Rasterization



Must paint old rectangle and new rectangle

High DPI = High amounts of work



Device

px/inch

iPad Mini	~ 160
Kindle Fire	~ 170
Nexus 7	~ 216
Macbook + Retina	~ 220
Chromebook Pixel	~ 239
Nexus 10	~ 300

Device
pixels



x4



HiDPI screens require 4x pixels!

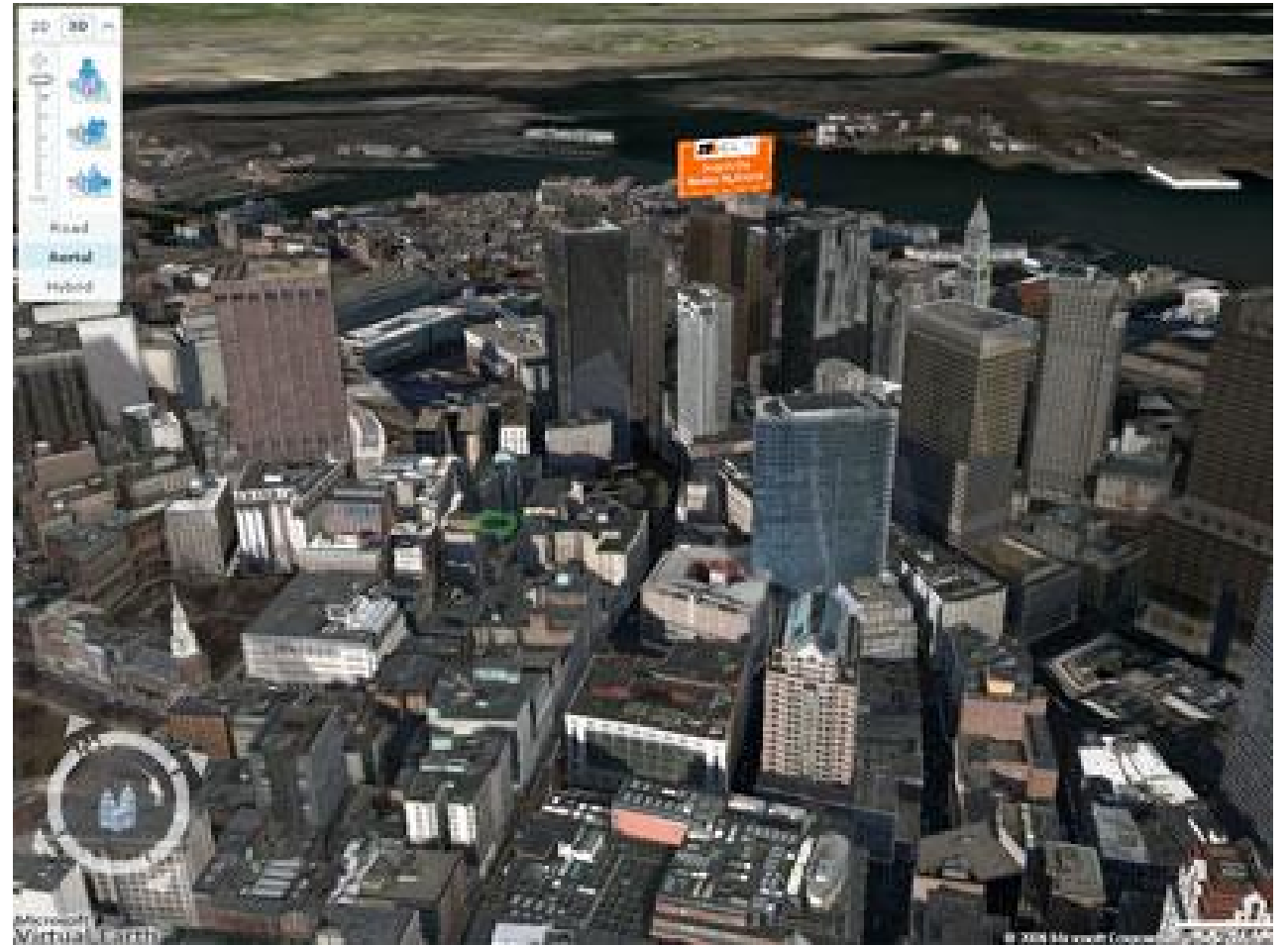
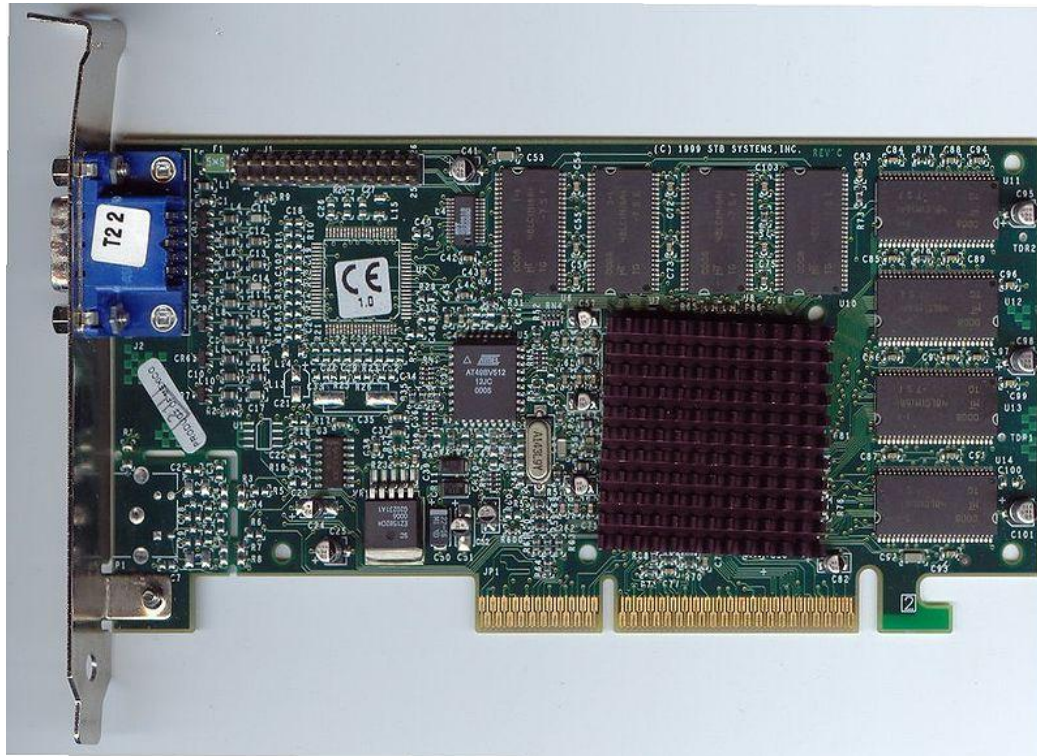
Which means 4x the amount of work to paint!





Hardware Compositing

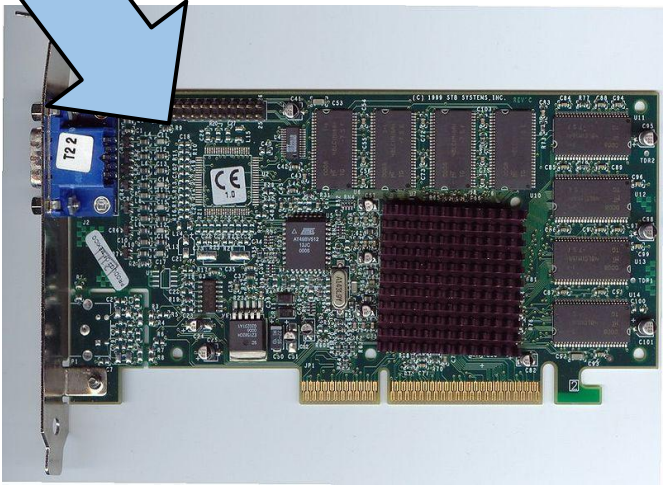
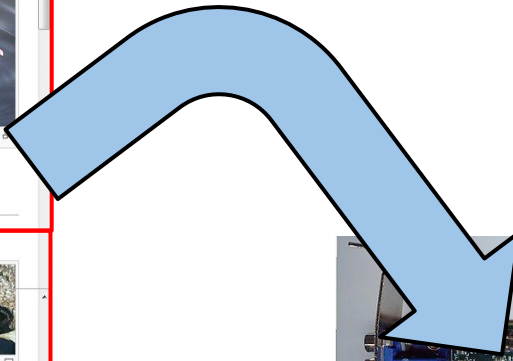
Using the GPU to make even faster websites

Graphics Processing Unit



Tiling Textures = Memory Win

<p>Emilián e rumagnòl</p> <p>Español</p> <p>Esperanto</p> <p>Euskara</p> <p>فارسی</p> <p>Français</p> <p>Gallego</p> <p>ગુજરાતી</p> <p>한국어</p> <p>ភាសាខ្មែរ</p> <p>Ido</p> <p>Bahasa Indonesia</p> <p>සිංහල</p>	<p>characteristic upending duck</p> <p>The overall body plan of ducks is elongated and broad, and the ducks are also relatively long-necked, albeit not as long-necked as the geese and swans. The body shape of diving ducks varies somewhat from this in being more rounded. The bill is usually broad and contains serrated lamellae, which are particularly well defined in the filter-feeding species. In the case of some fishing species the bill is long and strongly serrated. The scaled legs are strong and well developed, and generally set far back on the body. In the highly aquatic species the wings are very strong and are generally short and pointed, and the flight of ducks requires fast continuous strokes, requiring in turn strong wing muscles. Three species of steamer duck are almost flightless, however. Many species of duck are temporarily flightless while moulting, they seek out protected habitats with good food supplies during this period. This moult typically precedes migration.</p> <p>The drakes of northern species often have extravagant plumage, but that is moulted in summer to give a more female-like appearance, the "eclipse" plumage. Southern resident species typically show less sexual dimorphism, although there are exceptions like the Paradise Shelduck of New Zealand which is both strikingly sexually dimorphic and where the female's plumage is brighter than that of the male. The plumage of juvenile birds generally resembles that of the female.</p>	 <p>Male Mandarin Duck</p>
<p>Иррон</p> <p>Íslenska</p> <p>Italiano</p> <p>Basa Jawa</p> <p>ಕನ್ನಡ</p> <p>Kirundi</p> <p>Kreyòl ayisyen</p> <p>Қырық жазы</p> <p>Лезги</p> <p>Latina</p> <p>Latviešu</p> <p>Lietuvių</p> <p>Ligure</p> <p>සිංහල</p>	<p>Behaviour</p> <p>Feeding</p> <p>Ducks exploit a variety of food sources such as grasses, aquatic plants, fish, insects, small amphibians, worms, and small molluscs. Diving ducks and sea ducks forage deep underwater. To be able to submerge more easily, the diving ducks are heavier than dabbling ducks and therefore have more difficulty taking off to fly. Dabbling ducks feed on the surface of water or on land, or as deep as they can reach by up-ending without completely submerging.^[3] Along the edge of the beak there is a comb-like structure called a pecten. This strains the water squirting from the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items. A few specialized species such as the mergansers are adapted to catch and swallow large fish. The others have the characteristic wide flat beak adapted to dredging-type jobs such as pulling up waterweed, pulling worms and small molluscs out of mud, searching for insect larvae, and bulk jobs such as dredging out, holding, turning headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere, but the nostrils come out through hard horn.</p>	 <p>Pecten along the beak</p>
<p>Беларуская мов</p> <p>Nederlands</p> <p>Nedersaksies</p> <p>नेपाल भाषा</p> <p>日本語</p> <p>Норвуйск</p> <p>Norsk nynorsk</p> <p>Occitan</p> <p>ਪੰਜਾਬੀ</p> <p>Picard</p> <p>Plattdütsch</p> <p>Portugués</p> <p>Română</p> <p>Runa Simi</p>	<p>Breeding</p> <p>The ducks are generally monogamous, although these bonds generally last a single year only. Larger species and the more sedentary species (like fast river specialists) tend to have pairs that do so in favourable conditions (spring/summer or wet seasons). Ducks also tend to make a nest before breeding. Although mother ducks are very caring and protective of their young, they are not above abandoning some of their ducklings if they are physically stuck in an area they cannot get out of or are not prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by inconsistent, late hatching where a few eggs hatch long after the mother has abandoned the nest.^[citation needed]</p> <p>Communication</p> <p>Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from whistles, cooing, yodels, and grunts. Calls may be loud displaying calls or quieter contact calls.</p> <p>A common urban legend claims that duck quacks do not echo; however, this has been shown to be false. This myth was first debunked by the Acoustics Research Centre at the University of Salford in 2003 as part of the British Association's Festival of Science.^[3] It was also debunked in one of the earlier episodes of the popular Discovery Channel television show <i>MythBusters</i>.^[3]</p>	
	<p>Distribution and habitat</p>	



Caching Tiles

The image shows a screenshot of the Wikipedia page for 'Ducks' (en.wikipedia.org/wiki/Ducks). A red grid is overlaid on the page, dividing it into a 3x3 grid of tiles. The grid lines are thick and red. The page content is partially visible through the grid. The left sidebar shows a list of languages. The main content area includes sections for 'Etymology', 'Morphology', and 'Behaviour'. There are three images: a Pacific Black Duck, a Male Mandarin Duck, and a close-up of a duck's beak showing the pecten. The text is partially obscured by the grid lines.

Caching Tiles



Cache tiles for the top section of the Wikipedia page, including language lists and introductory text. A blue arrow points to this area.

Still in Cache, Not visible



Cache tiles for the middle section of the Wikipedia page, including sections like 'Morphology', 'Behaviour', and 'Feeding'. A red arrow points to this area.

Still in Cache, Visible

Cache tiles for the bottom section of the Wikipedia page, including sections like 'Breeding', 'Communication', and 'Ecology'. A red arrow points to this area.

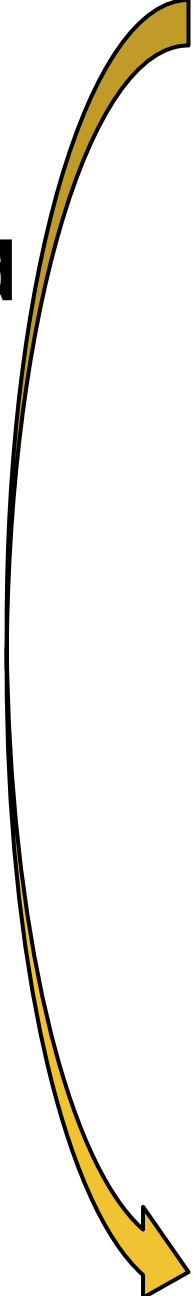
New Tiles added



New cache tiles for the bottom section of the Wikipedia page, including sections like 'Ecology' and 'Distribution and habitat'. A green arrow points to this area.



Tiles Recycled



en.wikipedia.org/wiki/Duck

7 References
8 External links

Etymology

The word duck comes from Old English *"dūce"* "diver", a derivative of the verb *"dūcan"* "to duck, bend down low as if to get under something, or dive", because of the way many species in the dabbling duck group feed by upending, compare with Dutch *duiken* and German *tauchen* "to dive". This word replaced Old English *ened/ænd* "duck", possibly to avoid confusion with other Old English words, like *ende* "end" with similar forms. Other Germanic languages still have similar words for "duck", for example, Dutch *eend* "duck" and German *Ente* "duck". The word *ened/ænd* was inherited from Proto-Indo-European, compare Latin *anas* "duck", Lithuanian *ąntis* "duck", Ancient Greek *néssa/néssa* (νήσσα, νήσσα) "duck", and Sanskrit *āti* "water bird", among others.

A duckling is a young duck in downy plumage^[1] or baby duck^[2] but in the food trade young adult ducks ready for roasting are sometimes labelled "duckling"^[citation needed]

A male duck is called a drake.

Morphology

The overall body plan of ducks is elongated and broad, and the ducks are also relatively long-necked. The bill is usually broad and somewhat serrated lamellae, which are particularly well developed in the filter-feeding species. The scaled legs are strong and webbed, and generally set out in a way that allows the duck to be a powerful swimmer. The flight of ducks is powerful, however. Many species of duck are temporarily flightless while moulting; they seek out protected habitat with good food supplies during this period. This moult typically precedes migration.

The drakes of northern species often have extravagant plumage, but in southern resident species typically show less sexual dimorphism, although there are exceptions like the Fulvous Shelduck of New Zealand which is both strikingly sexually dimorphic and where the female's plumage is brighter than that of the male. Like appearance, the "eclipse" plumage of juvenile birds

Ducks exploit a variety of food sources such as grasses, aquatic plants, fish, insects, small amphibians, worms, and small molluscs. Diving ducks and sea ducks forage deep underwater. To be able to submerge more easily, the diving ducks are heavier than dabbling ducks, and therefore have more difficulty taking off to fly.

Dabbling ducks feed on the surface of water or on land, or as deep as they can reach by up-ending without completely submerging.^[3] Along the edge of the beak there is a comb-like structure called a pecten. This strains the water squirting from the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items.

but the nostrils come out through hard horn.

Breeding

The ducks are generally monogamous, although these bonds generally last a single year only. Larger species and those more sedentary species (like fast river specialists) tend to have pair bonds that last numerous years. Most duck species breed once a year, choosing to do so in favourable conditions (spring/summer or wet seasons). Ducks also tend to make a nest before their young, they are not above abandoning some of their ducklings if they are physically stuck in an area where they cannot get out of or are not prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by inconsistent, late hatching where a few eggs hatch long after the mother has abandoned the nest.^[citation needed]

Communication

Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from quietest, cooing, yodels and grunts. Calls may be used for quieter contact calls or loud displaying calls or

A common urban legend claims that duck quacks do not echo; however, this has been shown to be false. This myth was first debunked by the Acoustics Research Centre at the University of Salford in 2007. The myth was also debunked in one of the earlier episodes of the popular Discovery Channel television show *Myth Busters*.^[5]

Ecology

Distribution and habitat

See also: *List of Anseriformes by population*

The ducks have a cosmopolitan distribution occurring across most of the world except for Antarctica. A number of species manage to live on sub-Antarctic islands like South Georgia and the Auckland Islands. Numerous ducks have managed to establish themselves on oceanic islands such as Hawaii, New Zealand and Kerguelen, although many of these species and populations are threatened or have become extinct.

Some duck species, mainly those breeding in the temperate and subtropical Northern Hemisphere, are migratory; those in the tropics, however, are generally not. Some ducks, particularly in Australia where rainfall is patchy and erratic, are nomadic, seeking out temporary lakes and pools that form after localised heavy rain.^[citation needed]

Wading ducks have many predators. Ducklings are particularly vulnerable, since their inability to fly makes them easy prey not only for predatory birds but also for large fish like pike, crocodilians, and other aquatic predators, and brooding females may be caught unaware by eagles.

Adult ducks are fast fliers, but may be caught on the water by large aquatic predators including big fish such as the North American muskie and the European pike. In flight, ducks are safe from all but a few predators such as humans and the Peregrine Falcon, which regularly uses its speed and strength to catch ducks.

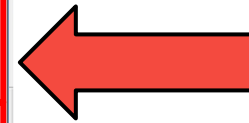
Ducks' nests are raided by birds, such as hawks or owls.

Two Mallard ducks, a female (top) and a male (bottom).

en.wikipedia.org/wiki/Ducks

Pre-Painting

<p>7 References 8 External links</p>	<h3>Etymology</h3> <p>The word duck comes from Old English "dōce" "dive", a derivative of the verb "dōcan" "to duck, bend down", because of the way many species in the dabbling duck group feed by upending; compare with Dutch <i>duiken</i> "to duck" and German <i>tauchen</i> "to dive". This word replaced Old English <i>ened/ēnid</i> "duck", possibly to avoid confusion with other Old English words like <i>ende</i> "end" with similar forms. Other Germanic languages still have similar words for "duck", for example, Dutch <i>eend</i> "duck" and German <i>Einte</i> "duck". The word <i>ened/ēnid</i> was inherited from Proto-Indo-European; compare Latin <i>anas</i> "water bird", among others.</p> <p>A duckling is a young duck in downy plumage^[1] or baby duck, but in the food trade young adult ducks "duckling"^[citation needed].</p> <p>A male duck is called a drake.</p>	<p>how as if to get under something, or dive", and German <i>tauchen</i> "to dive". This word replaced Old English <i>ened/ēnid</i> "duck", possibly to avoid confusion with other Old English words like <i>ende</i> "end" with similar forms. Other Germanic languages still have similar words for "duck", for example, Dutch <i>eend</i> "duck" and German <i>Einte</i> "duck". The word <i>ened/ēnid</i> was inherited from Proto-Indo-European; compare Latin <i>anas</i> "water bird", among others.</p> <p>A duckling is a young duck in downy plumage^[1] or baby duck, but in the food trade young adult ducks "duckling"^[citation needed].</p> <p>A male duck is called a drake.</p>
	<h3>Morphology</h3> <p>The overall body plan of ducks is elongated and broad, and the ducks are also relatively long-necked, although not as long-necked as the geese and swans. The body shape of diving ducks varies somewhat from this being more rounded. The bill is usually broad and contains serrated lamellae, which are particularly well defined in the filter-feeding species. The case of some fishing species the bill is long and strongly serrated. The scaled legs are short and well developed, and generally set far back on the body, more so in the highly aquatic species. The wings are very strong and are generally short and pointed, and the flight of ducks is the strongest fliers, however. Many species are temporarily flightless while moulting; they seek out protected habitat with good food supplies during this period. This moult typically precedes migration.</p> <p>The drake of northern species often have extravagant plumage, but that is moulted in summer to give more female-like appearance, the "eclipse" plumage. Southern resident species typically show less sexual dimorphism, although there are exceptions like the Paradise Shelduck of New Zealand which is both strikingly sexually dimorphic and here the female's plumage is brighter than that of the male. The plumage of juvenile birds generally resembles that of the female.</p>	<p>of duck are temporarily flightless while moulting; they seek out protected habitat with good food supplies during this period. This moult typically precedes migration.</p> <p>The drake of northern species often have extravagant plumage, but that is moulted in summer to give more female-like appearance, the "eclipse" plumage. Southern resident species typically show less sexual dimorphism, although there are exceptions like the Paradise Shelduck of New Zealand which is both strikingly sexually dimorphic and here the female's plumage is brighter than that of the male. The plumage of juvenile birds generally resembles that of the female.</p>
	<h3>Behaviour</h3> <p>Ducks exhibit a variety of food sources such as grasses, aquatic plants, fish, insects, small amphibians, worms, and small molluscs. Diving ducks and sea ducks forage deep underwater. They are able to submerge more easily, the diving ducks are heavier than dabbling ducks, and</p>	<p>Diving ducks and sea ducks forage deep underwater. They are able to submerge more easily, the diving ducks are heavier than dabbling ducks, and</p>
	<h3>Feeding</h3> <p>Dabbling ducks feed on the surface of water or on land, as deep as they can reach by up-ending with their beak. There is a comb-like structure called a pecten on the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items.</p> <p>A few specialized species such as the mergansers are adapted to catch and swallow large fish.</p> <p>The others have the characteristic wide flat beak adapted to dredging-type jobs such as pulling up waterweed, pulling worms and small molluscs out of mud, searching for insect larvae, and bulk jobs such as dredging out, holding, turning headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere.</p>	<p>Dabbling ducks feed on the surface of water or on land, as deep as they can reach by up-ending with their beak. There is a comb-like structure called a pecten on the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items.</p> <p>A few specialized species such as the mergansers are adapted to catch and swallow large fish.</p> <p>The others have the characteristic wide flat beak adapted to dredging-type jobs such as pulling up waterweed, pulling worms and small molluscs out of mud, searching for insect larvae, and bulk jobs such as dredging out, holding, turning headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere.</p>
	<h3>Breeding</h3> <p>The ducks are generally monogamous, although these bonds that last numerous years. Most duck species breed once a year, choosing to do so in favourable conditions (spring/summer or wet seasons). Although mother ducks are very caring and protective of their young, they are not above abandoning some of their ducklings if they are physically prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by eggs hatch long after the mother has abandoned the nest.^[citation needed]</p>	<p>The ducks are generally monogamous, although these bonds that last numerous years. Most duck species breed once a year, choosing to do so in favourable conditions (spring/summer or wet seasons). Although mother ducks are very caring and protective of their young, they are not above abandoning some of their ducklings if they are physically prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by eggs hatch long after the mother has abandoned the nest.^[citation needed]</p>
	<h3>Communication</h3> <p>Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the male scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from whistles, cooing, yodels and grunts. Calls may be loud displaying calls or quieter contact calls.</p> <p>A common urban legend claims that duck quacks do not echo; however, this has been shown to be false in 2003 as part of the British Association's Festival of Science.^[4] It was also debunked in one of the earlier episodes of the popular Discovery Channel television show <i>MythBusters</i>.^[5]</p>	<p>Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the male scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from whistles, cooing, yodels and grunts. Calls may be loud displaying calls or quieter contact calls.</p> <p>A common urban legend claims that duck quacks do not echo; however, this has been shown to be false in 2003 as part of the British Association's Festival of Science.^[4] It was also debunked in one of the earlier episodes of the popular Discovery Channel television show <i>MythBusters</i>.^[5]</p>
	<h3>Ecology</h3> <h4>Distribution and habitat</h4> <p>See also: <i>List of Anseriformes by population</i></p> <p>The ducks have a cosmopolitan distribution occurring across most of the world except for Antarctica. Antarctic lands like South Georgia and the Auckland Islands. Numerous ducks have managed to establish themselves on oceanic islands such as Hawaii, New Zealand and Kerguelen, although many of these species and populations are threatened or have become extinct.</p> <p>Some duck species, mainly those breeding in the temperate and Arctic Northern Hemisphere, are migratory; those in the tropics, however, are generally not. Some ducks, particularly in Australia where rainfall is patchy and erratic, are nomadic, seeking out the temporary lakes and pools that form after localised heavy rain.^[citation needed]</p>	<p>The ducks have a cosmopolitan distribution occurring across most of the world except for Antarctica. Antarctic lands like South Georgia and the Auckland Islands. Numerous ducks have managed to establish themselves on oceanic islands such as Hawaii, New Zealand and Kerguelen, although many of these species and populations are threatened or have become extinct.</p> <p>Some duck species, mainly those breeding in the temperate and Arctic Northern Hemisphere, are migratory; those in the tropics, however, are generally not. Some ducks, particularly in Australia where rainfall is patchy and erratic, are nomadic, seeking out the temporary lakes and pools that form after localised heavy rain.^[citation needed]</p>
	<h3>Predators</h3> <p>Worldwide ducks have many predators. Ducklings are particularly vulnerable, since their inability to fly makes them easy prey not only for predatory birds but also large fish like pike, crocodilians, and other aquatic hunters, including fish-eating birds such as herons. Ducks' nests are raided by land-based predators, and brooding females may be caught unaware on the nest by mammals, such as foxes, or large birds, such as hawks or eagles.</p> <p>Adult ducks are fast fliers, but may be caught on the nest by large aquatic predators including the European pike. In flight, ducks are safe from all but a few predators such as humans and the Peregrine Falcon, which regularly uses its speed and</p>	<p>Worldwide ducks have many predators. Ducklings are particularly vulnerable, since their inability to fly makes them easy prey not only for predatory birds but also large fish like pike, crocodilians, and other aquatic hunters, including fish-eating birds such as herons. Ducks' nests are raided by land-based predators, and brooding females may be caught unaware on the nest by mammals, such as foxes, or large birds, such as hawks or eagles.</p> <p>Adult ducks are fast fliers, but may be caught on the nest by large aquatic predators including the European pike. In flight, ducks are safe from all but a few predators such as humans and the Peregrine Falcon, which regularly uses its speed and</p>

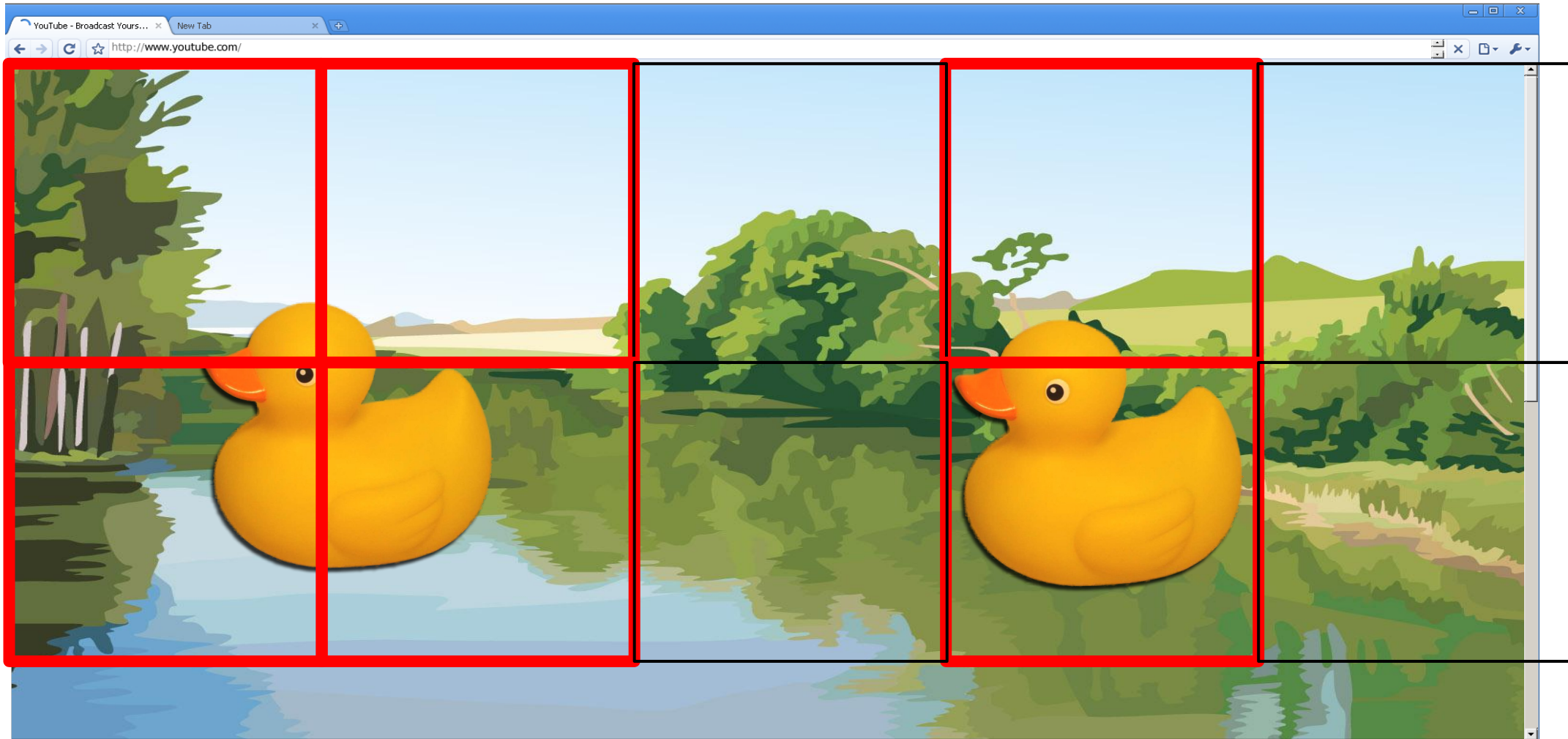


Visible tiles

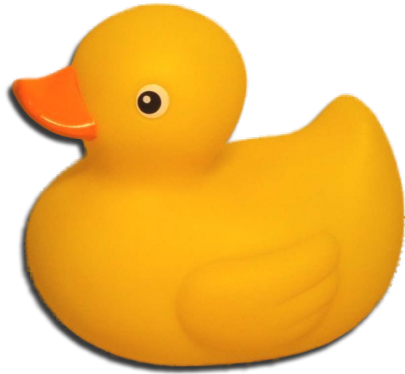


Not yet-visible, but pre-painted

Tiling and Animation



Animation & Rasterization

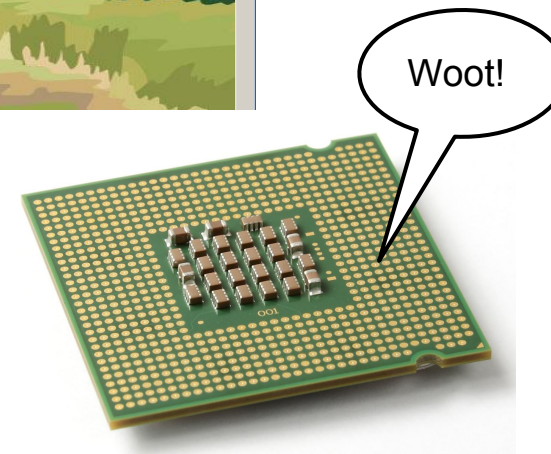
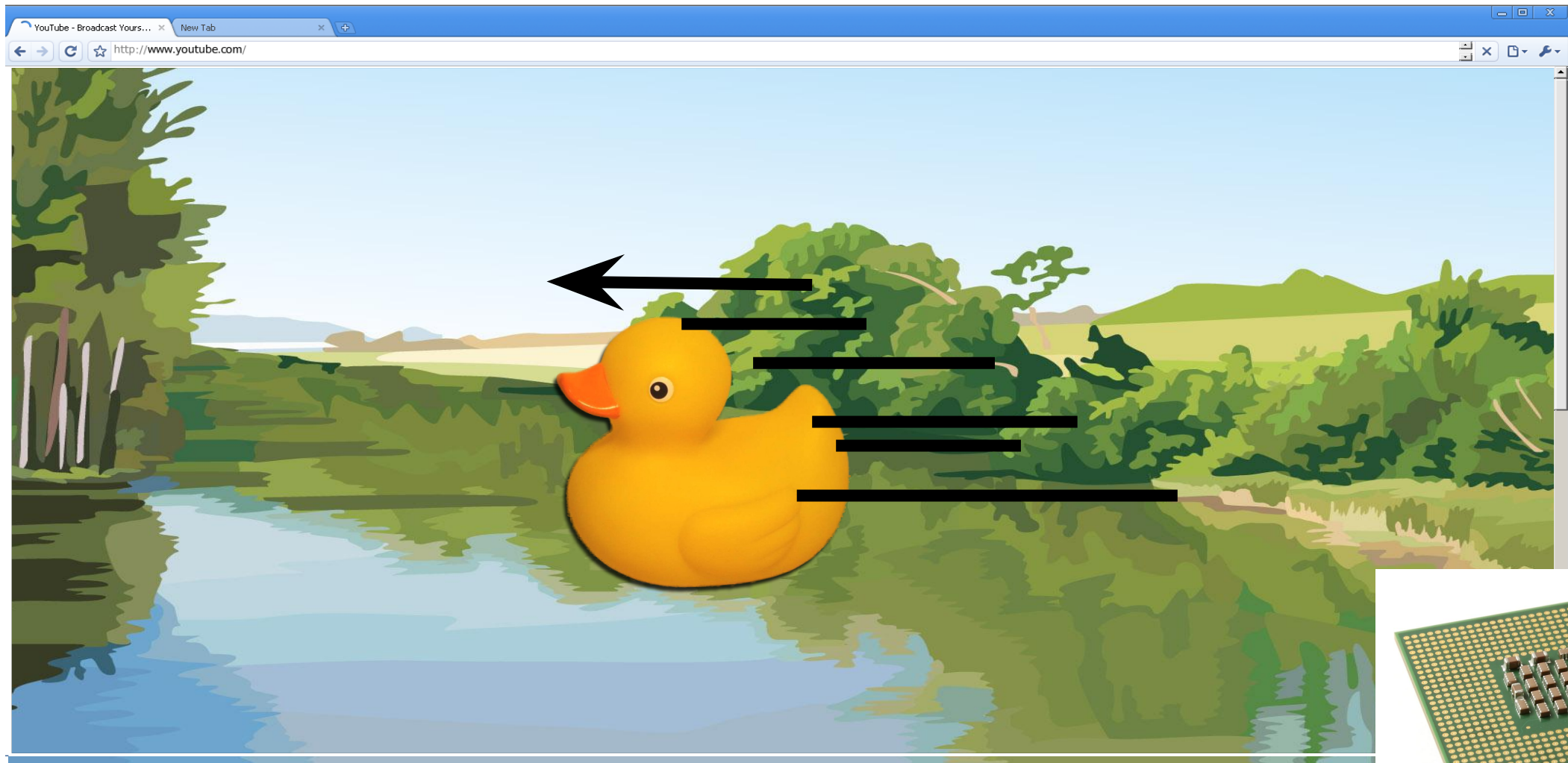


GPU Layer 1



GPU Layer 2

Tiling and Animation





Controlling **Layers** with CSS

How developers can use all this.

Hands-Free layer promotion

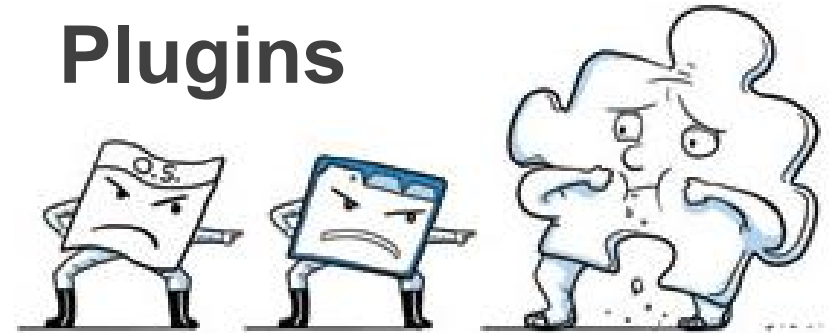


Canvas

Video



Plugins



3D Transform = Auto layer promotion



- TranslateZ
- ScaleZ
- RotateX
- RotateY
- RotateZ
- Translate3D
- Scale3D
- Rotate3D
- backface-visibility:
hidden

2D Transforms do
NOT create layer

CSS Animations

OPACITY and TRANSFORM





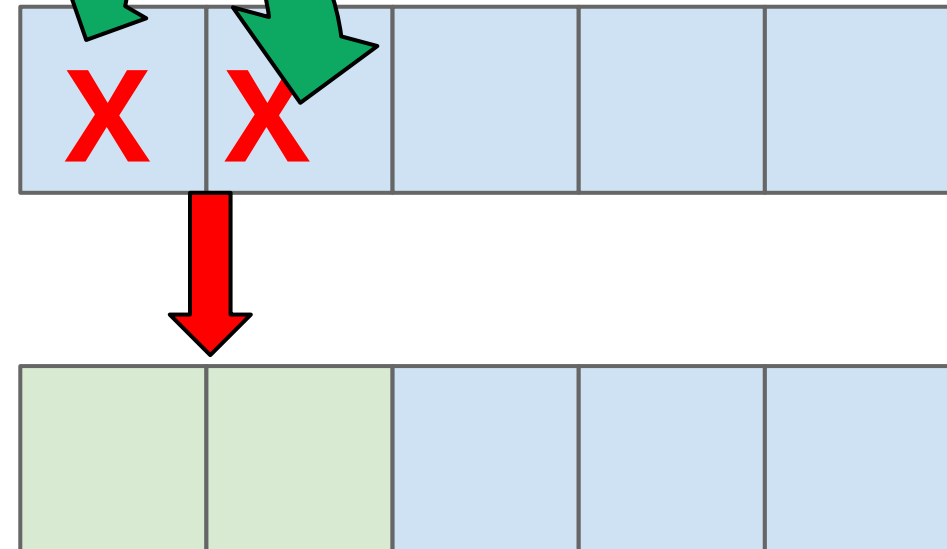


Tradeoffs and **consequences**

The GPU is not a silver bullet!

The cost of too many layers : Additional Memory

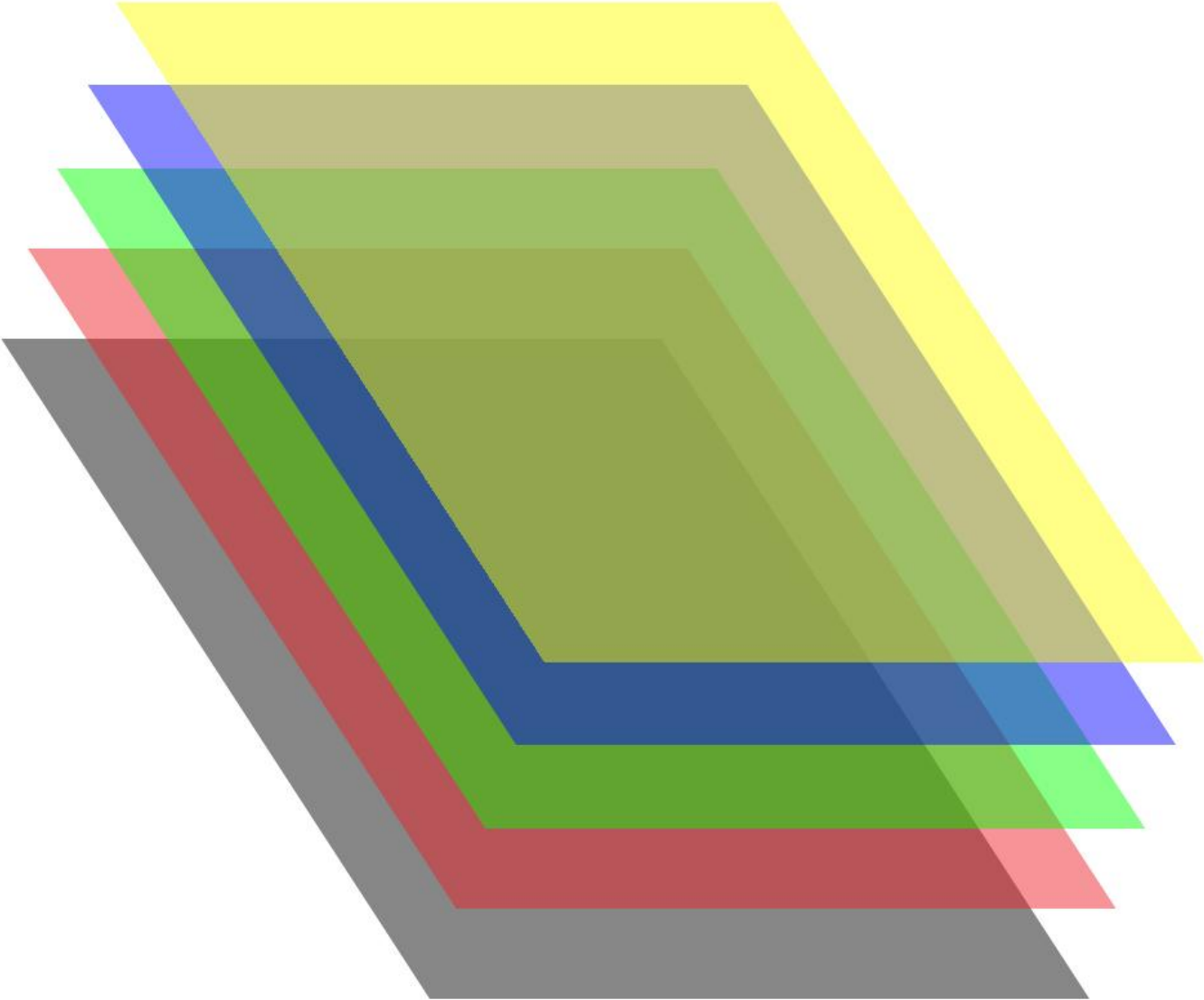
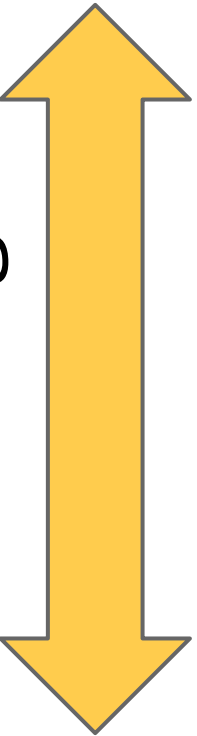
Ελληνικά Emilián e rumagnòl Español Esperanto Euskara فارسی Français Gaeilge Galego 日本語 한국어 Ἑλληνικά Ido Bahasa Indonesia Հայերեն	characteristic upending neck The overall body plan of ducks is elongated but not as long-necked as the geese and swans. The body shape of ducks is rounded. The bill is usually broad and contains serrated lamellae, which are particularly useful for filtering food from this being more abundant. In the case of some fishing species the bill is long and strongly serrated far back on the body, more so in the highly aquatic species. The wings are very long and require fast continuous strokes, requiring in turn strong wing muscles. Three species of duck are temporarily flightless while moulting; they seek out protected habitats and precedes migration. The drakes of northern species often have extravagant plumage, but that is moulted in summer to give a more female-like appearance, the " eclipse" plumage. Southern species typically show less sexual dimorphism, although there are exceptions like the Paradise Shelduck of New Zealand which is both strikingly sexually dimorphic and where the female's plumage generally resembles that of the female.	ted and broad, and the ducks are also... The scaled legs are strong and generally set long and are generally serrated. However, many species of steamer duck have webbed feet. This moult typically precedes migration.	 Male Mandarin Duck
Ирландски Íslenska Italiano Basa Jawa ಕನ್ನಡ ಕുರುಂಡಿ Қыргыз тили Қазақ тили Lèmn Latina Latviešu Lietuvių Ligur मराठी	Feeding Ducks exploit a variety of food sources such as grasses, aquatic plants, fish, insects, small amphibians, worms, and small molluscs. Diving ducks and sea ducks forage deep underwater. To be able to submerge more easily, the diving ducks are heavier than dabbling ducks and therefore have more difficulty taking off to fly. Dabbling ducks feed on the surface of water or on land, or as deep as they can reach by up-ending without completely submerging. ^[5] Along the edge of the beak there is a comb-like structure called a pecten. This strains the green feathers and to hold slippery food items. A few specialized species such as the mergansers are adapted to catch and swallow large fish. The others have the characteristic wide flat beak adapted to dredging-type jobs such as pulling up waterweed, pulling worms and small molluscs out of mud, searching for insect larvae, and bulk jobs such as dredging out, holding, or turning headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere, but the nostrils come through hard horn.	ts, small amphibians, worms, and small molluscs. easily, the diving ducks are heavier than dabbling ducks and ch by up-ending without completely submerging. ^[5] Along the ter squirting from the side of the beak and traps any food. The water squirting from the side of the beak and traps any food. The	 Pecten along the beak
Nederlands Nedersaksies नेपाल भाषा 日本語 Норвунд Norsk bokmål Norsk nynorsk Occitan ਪੰਜਾਬੀ Picard Plattdüütsch Portugués Română Runa Simi	Breeding The ducks are generally monogamous, although these bonds generally last a single year only. Larger species and the more sedentary species (like fast river specialists) tend to have pair-bonds that last numerous years. Most duck species breed once a year, choosing to do so in favourable conditions (spring/summer or wet seasons). Ducks also tend to make a nest before breeding. Although mother ducks are very caring and protective of their young, they are not above abandoning some of their ducklings if they are physically stuck in an area they cannot get out of or are not prospering due to genetic defects or sickness brought about by hypothermia, starvation, or disease. Ducklings can also be orphaned by inconsistent, late hatching where a few eggs hatch long after the mother has abandoned the nest. ^[citation needed]	ow large fish. ch as pulling up waterweed, pulling worms and small molluscs out ring headfirst, and swallowing a squirming frog. To avoid injury when digging into sediment it has no cere.	
	Communication Despite widespread misconceptions, only the females of most dabbling ducks "quack". For example, the scaup – which are diving ducks – make a noise like "scaup" (hence their name), and even among the dabbling ducks, the males never quack. In general, ducks make a wide range of calls, ranging from whistles, cooing, yodeling and grunts. Calls may be loud displaying calls or quieter contact calls.		
	Ecology A common urban legend claims that duck quacks do not echo; however, this has been shown to be false. This myth was first debunked by Salford in 2003 as part of the British Association's Festival of Science. ^[4] It was also debunked in one of the earlier episodes of the popular discovery Channel television show <i>MythBusters</i> . ^[5]		
	Distribution and habitat		



GPU Tile Cache

The cost of too many layers : Additional **Processing**

Sorting

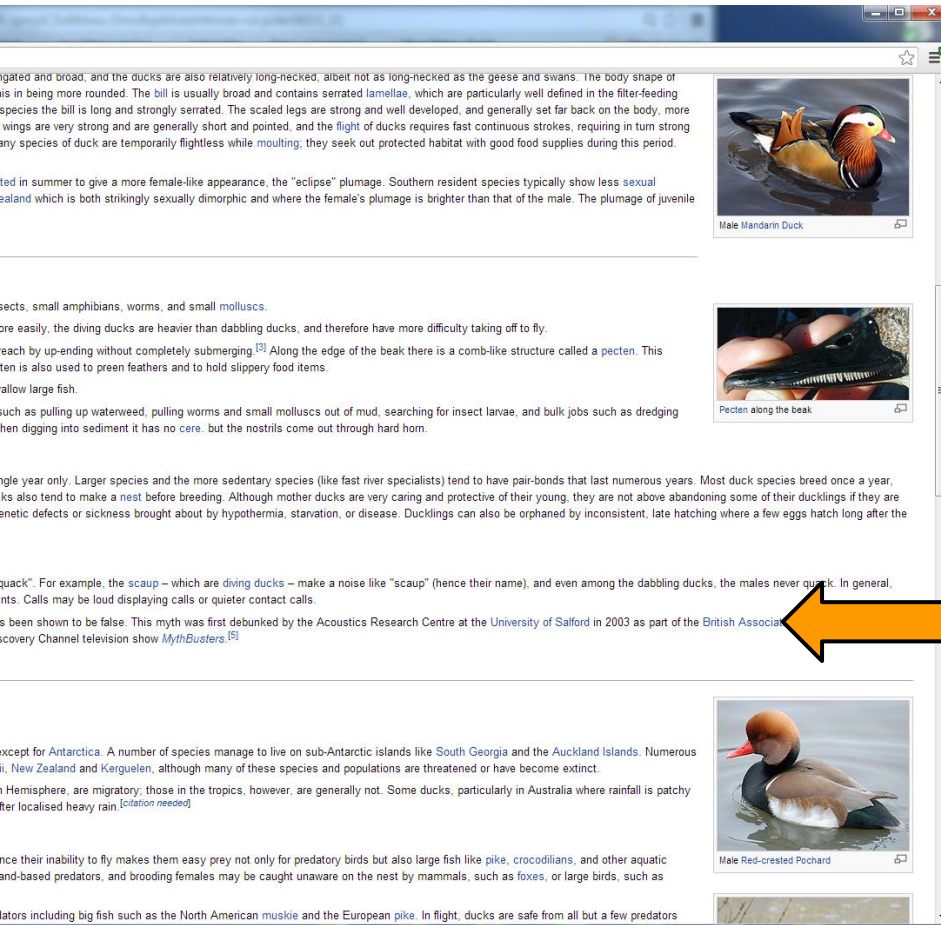


Layering & Animation tradeoffs



translateZ(0) ==> Layer promotion
==> Memory Usage

display:none invalidates pre-painting



display:none → display:block
Triggers Paint

display:block + translateZ(0)
Load-time Paint

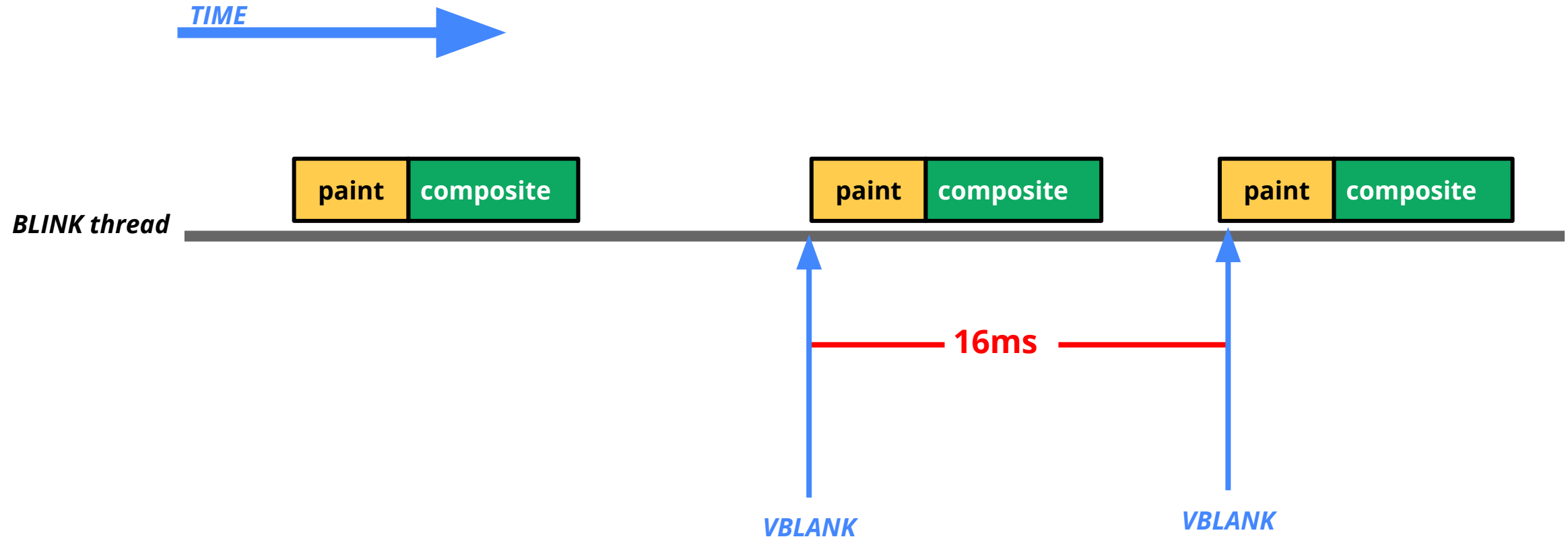
Gambling on potential usage



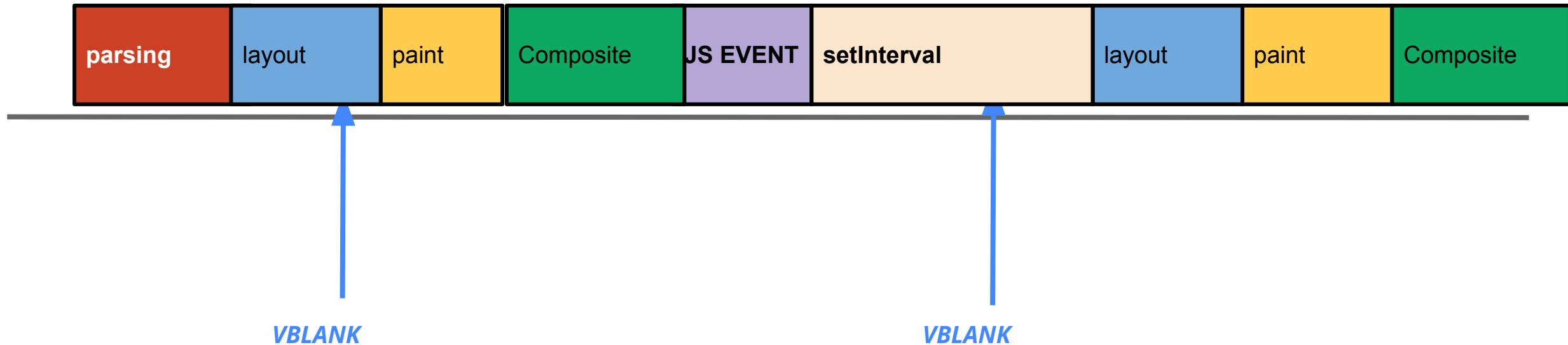
Input with **Threaded** Compositing

*We should be able to render w/o needing to be **blocked** by input*

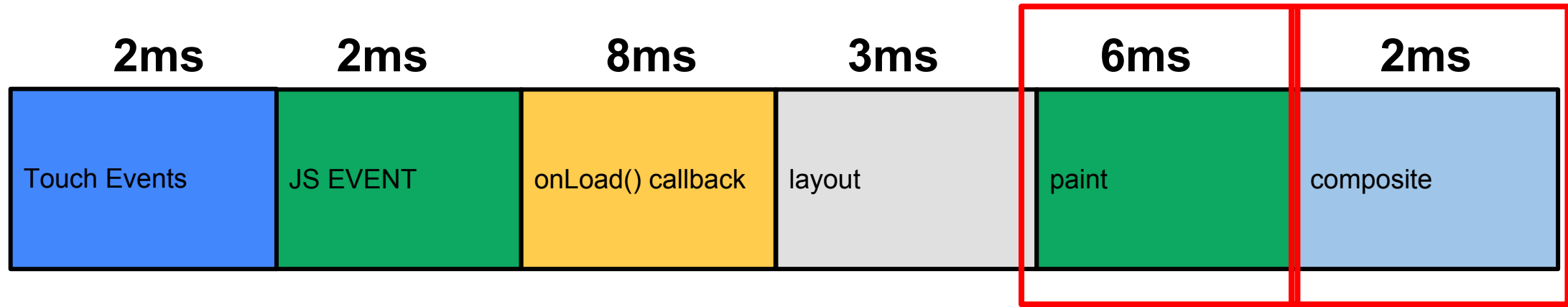
Responding to paint requests



Single threaded event queue



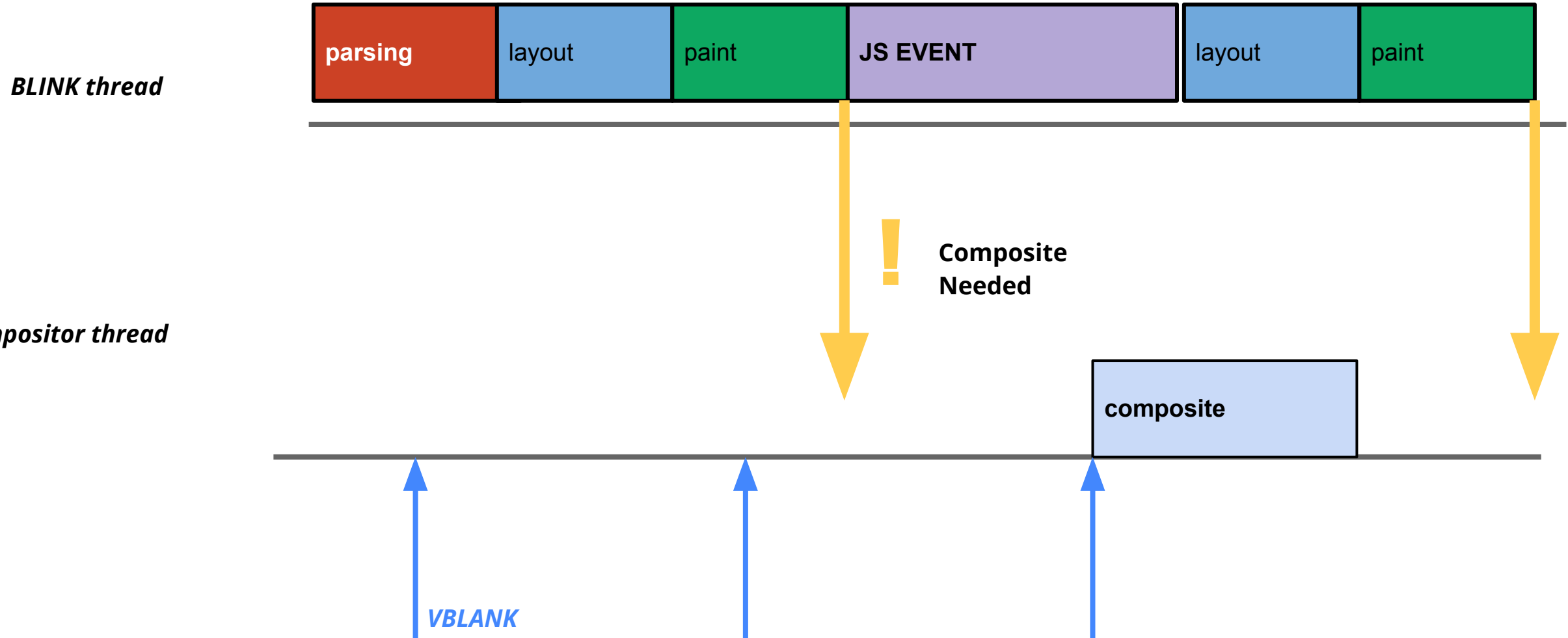
Outta Time



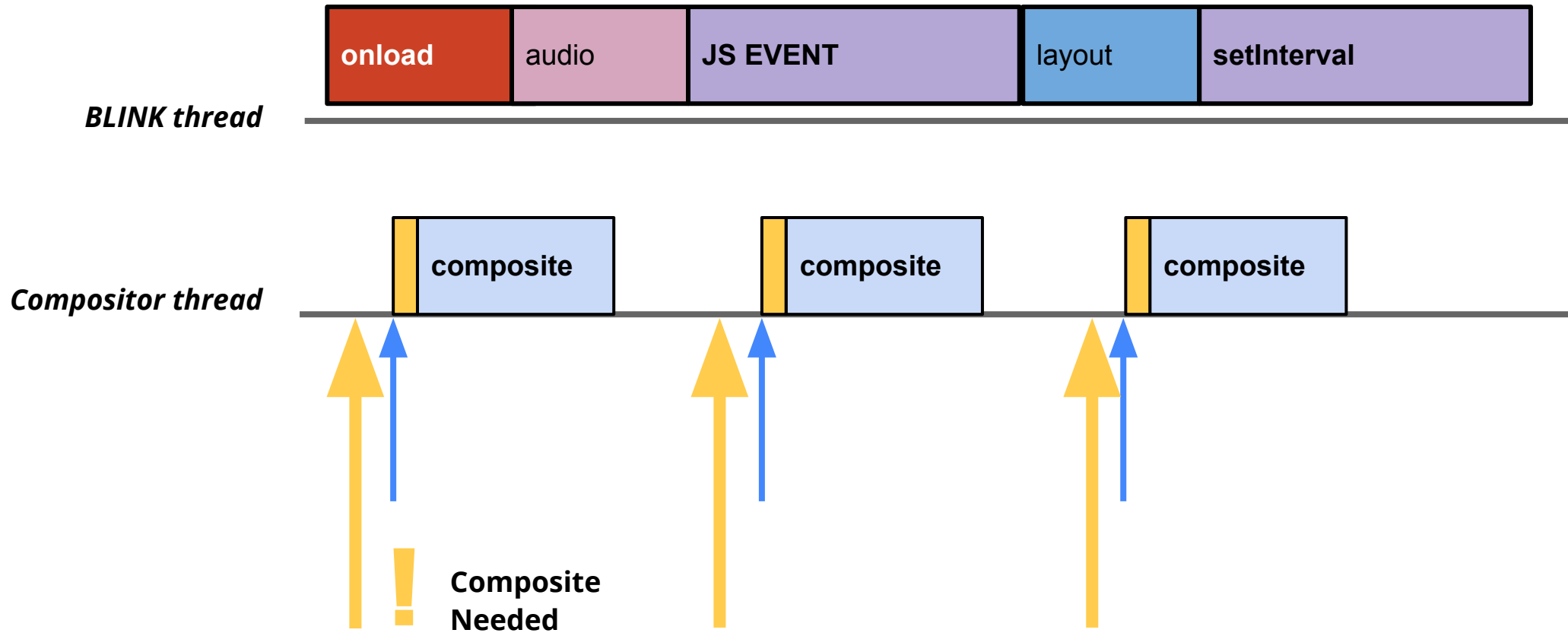
16MS

"Multi Threaded Painting"

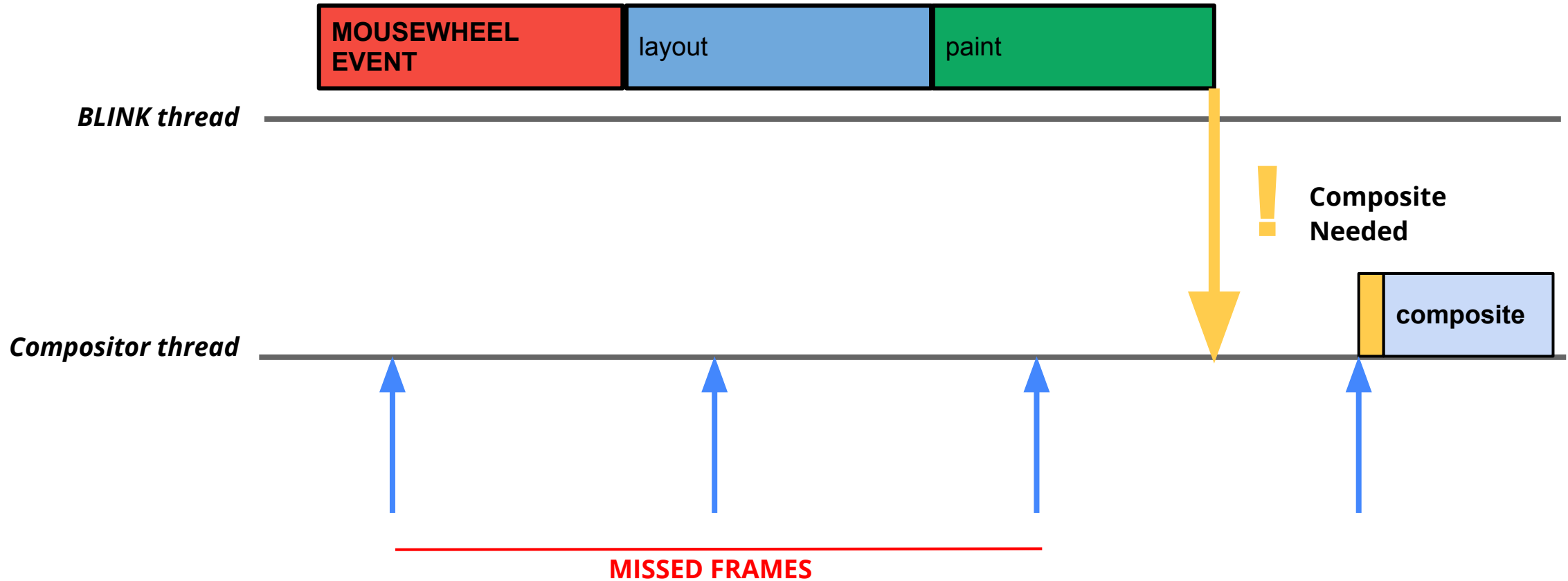
Threaded compositing - Multithreaded



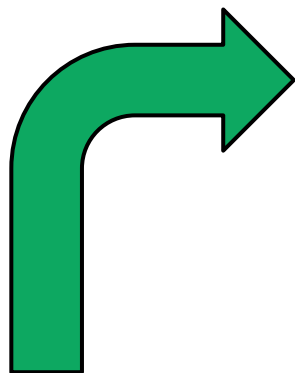
Let the browser scroll



Don't use custom scroll libraries



Custom scroll handler == Slow Performance



```
<style>  
#staticHeader  
{  
  position: fixed  
  z-index: 0  
}  
</style>
```

CSS

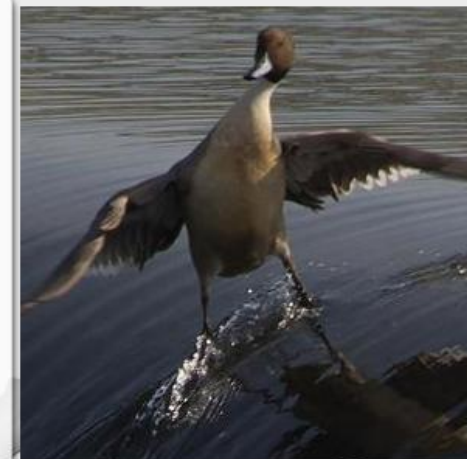
DUCK SURFING 101



Seriously, look at this duck, it's standing on the back of another duck, like "What up, you're my new boat".

Duck surfing began back in Greece, but they called it "βάρκα πάπια" Or "Duck Boat" and has since evolved into a legitimate sport

See this duck? It's doing it wrong. Duck surfing requires a Duck *standing* on another Duck. Professional leagues have formed with the notion that the Duck only need to *punch the curl*, (thus removing the lower Duck) but this is incorrect in terms of the traditional art.





Tooling and **insight**

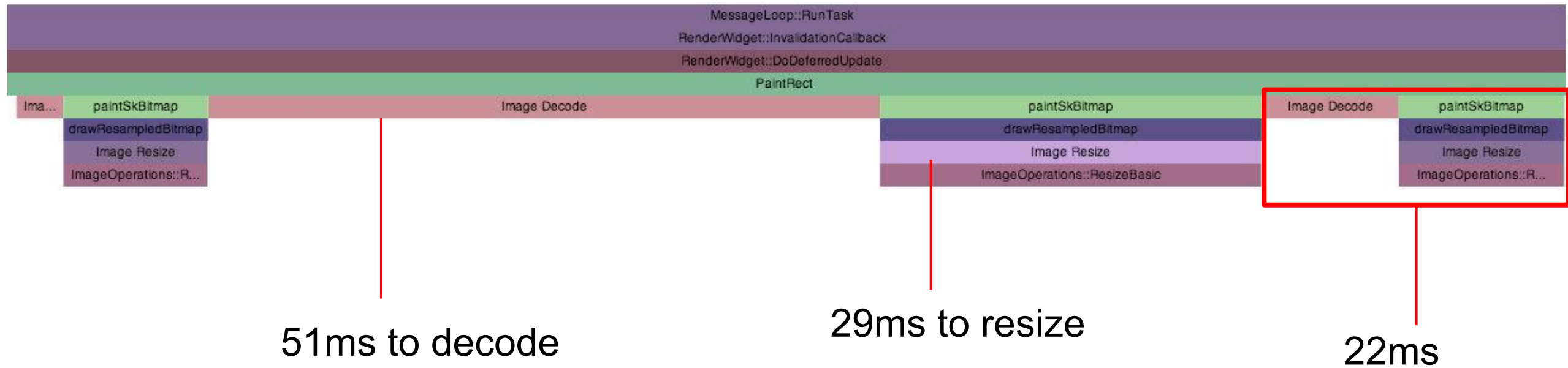
Tips and tools navigating Accelerated compositing.

How to see what layers you have

Turn on "show layer borders" in devtools options

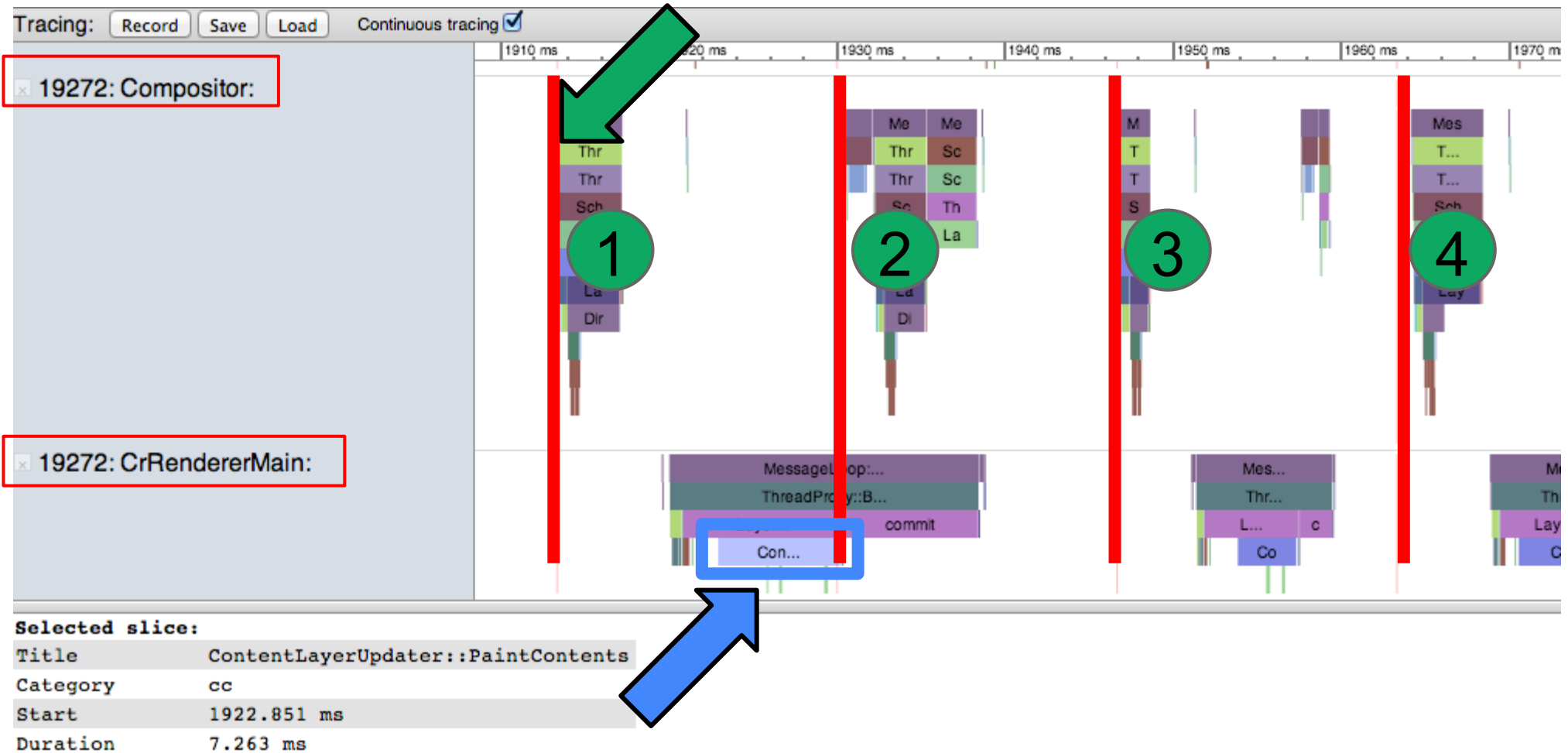


chrome://tracing



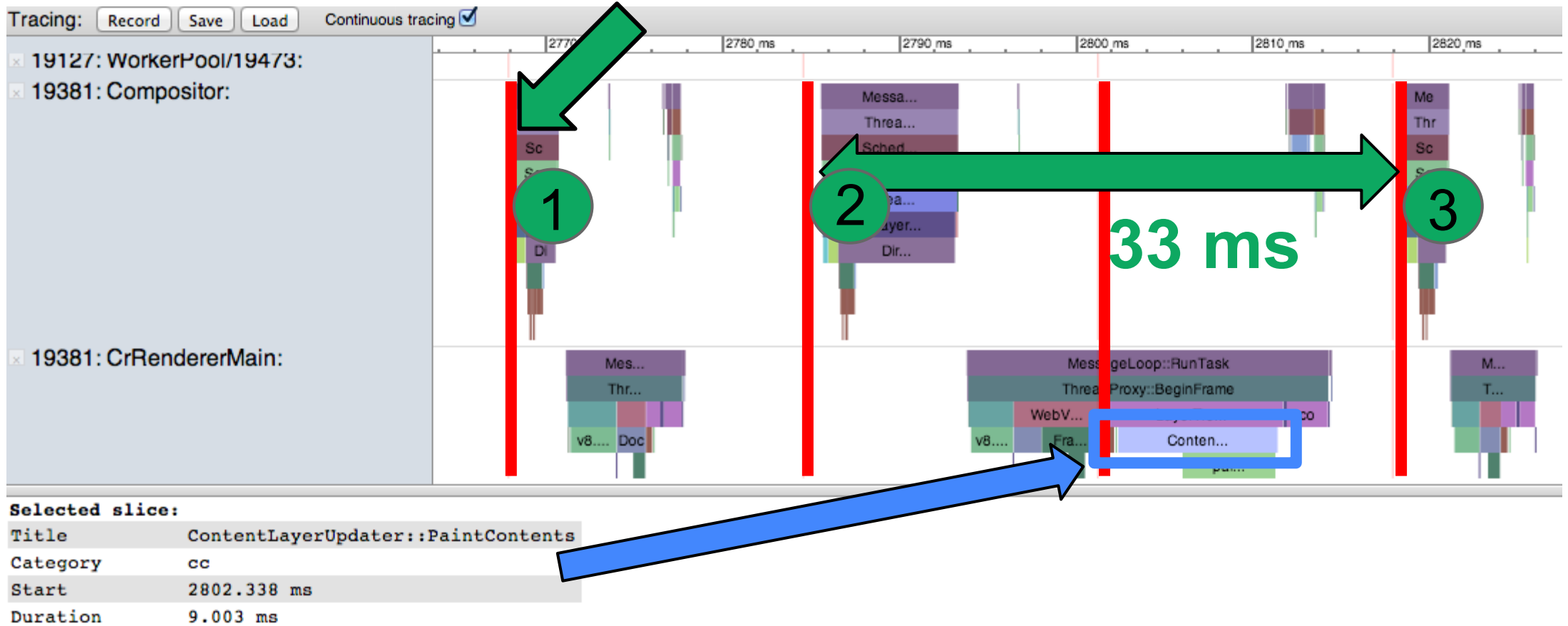
Browser-driven scroll

COMPOSITE!



JS driven Scroll

COMPOSITE!



Webpage design with the **GPU** in mind

- GPU + Layers = **faster** rendering
- Too many layers = **seriously** bad time
- Let browser handle scrolling = steady **frame rate**
- Use **tooling** to show off how many layers you have

</Thank You!>



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+Colt McAnlis

#perfmatters

 goo.gl/webperf





Google
Developers