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CURSOR TRAIL IN ONLINE MEETING

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ABSTRACT

Techniques are described to intelligently display a presenter's cursor trail in an online meeting to enable all attendees in the meeting to easily recognize which part of shared content the presenter has recently discussed and/or is currently discussing. These techniques are completely automatic and therefore require no extra effort for the presenter or the attendees. The cursor trail is so tidy and intelligent that a convenient user experience is guaranteed. Productivity of collaboration in online meeting can thus be significantly improved.

DETAILED DESCRIPTION

Figure 1 below illustrates an online meeting in which Alice is sharing her desktop. She is introducing a database diagram and she moves her mouse (cursor) as she talks to indicate where in the diagram she is currently referencing. In this example, first Alice talks about the Divisions, Products, Payment_methods, and Payments tables, and her cursor is moving around these four tables. Then, her focus changes to the next group of tables (Order_details, Order_status, and Orders). Accordingly, she moves her cursor to these tables to indicate that she is talking about them. After that, she focuses on the Client_credits, Client_balance_sheet, Client_divisions, and For_GD_album tables and her cursor moves there, too.

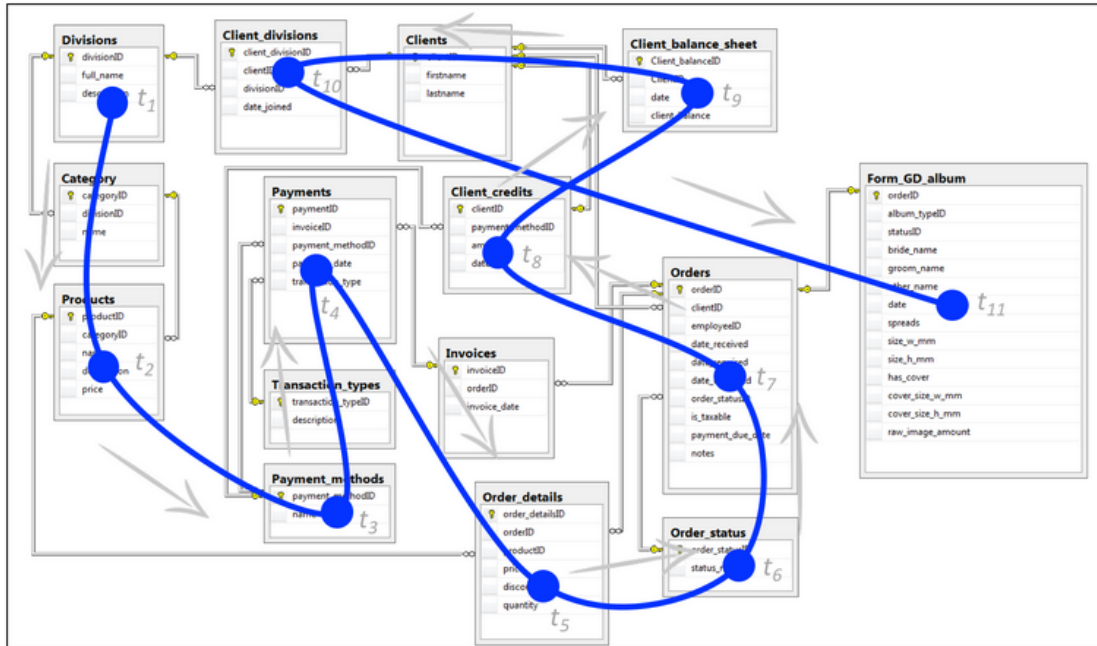


Figure 1

As shown, Alice is sharing her desktop and moving cursor around for focus indication. However, there are several problems with the mechanism illustrated in Figure 1 above. First, Alice might move her mouse so fast that Bob, a remote viewer in the online meeting, cannot effectively catch up with Alice's cursor trail. Second, Alice's cursor may not be sufficiently distinct from the background (e.g., of similar color as background or of relatively small size compared to the entire screen) to be recognized. Moreover, if Bob has weak vision, he may not be able to effectively catch up with Alice's cursor trail. Third, if Charlie joins while it is ongoing, for example when Alice's cursor is hovering over the Orders table, Charlie cannot know where Alice's cursor was a moment ago (i.e., the Payments, Order_details, and Order_status tables).

Thus, remote viewers in the same meeting may not be able to catch up with Alice's cursor trail. This is a visual information gap between the meeting presenter and the audience. This gap is critical in online meetings since audience's audible information is out of sync with visual information, and therefore detracts from online meeting user experience and collaboration productivity.

Accordingly, techniques are described to automatically and intelligently indicate a presenter's cursor trail to solve this problem. The presenter's cursor movement and mouse events are captured and broadcast in online meeting so that all attendees in the meeting are

able to see clearly what the presenter has most recently been talking about and what the presenter is currently talking about. First, the presenter's meeting client captures the presenter's cursor position and mouse events at a reasonable frequency. The data is broadcast in the meeting in real time. Next, the viewer's meeting client receives and analyzes the data, and displays it in a transparent layer in an intelligent manner.

The term "prominent points" is used herein to describe certain points. One type of prominent point are point is around which the presenter moves the cursor over and over again (which are collapsed to a single point). A second type of prominent point arises when the presenter hovers his cursor over a single point for a long time. A third type of prominent point arises when the presenter has made a mouse event (e.g., single click, double click, mouse down, mouse up, etc.). All other points are referred to herein as "transient points." prominent point and transient point. Prominent points and transient points reflect the presenter's different behaviors and different intentions and, accordingly, are processed and presented in different ways. Prominent points are rendered as solid circles while transient points are rendered as fitting curves (see https://en.wikipedia.org/wiki/Curve_fitting) through them. Circles on prominent points and fitting curves over transient points together make the cursor trail.

When the presenter is talking about a relatively small area, it is quite common for the presenter to move his cursor within that area over and over again. For example, as illustrated in Figure 2 below, the presenter does so and makes a trail similar to a complex knot, even though the presenter did not intend to show the audience such a mess. Instead, the presenter simply wants to express focus on a small area.

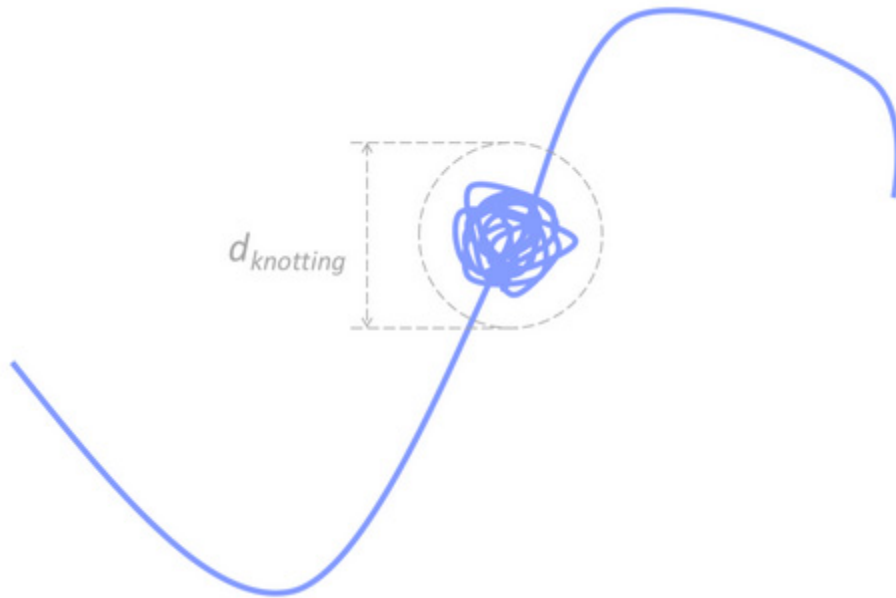


Figure 2

Therefore, in order not to display the cursor trail in such a mess while clearly expressing the presenter's intention, the concept of "points collapse" is introduced. If the cursor is frequently moving around a relatively small area which can be calculated by a diameter of $d_{knotting}$, all the sequential points in that area are replaced with a single point at the center of that area, as illustrated in Figure 3 below. Thus, the sequential points in that area collapse to a single point. With points collapse, the cursor trail becomes clearer and less redundant. The collapsed single point clearly represents the presenter's intention and is therefore a prominent point.

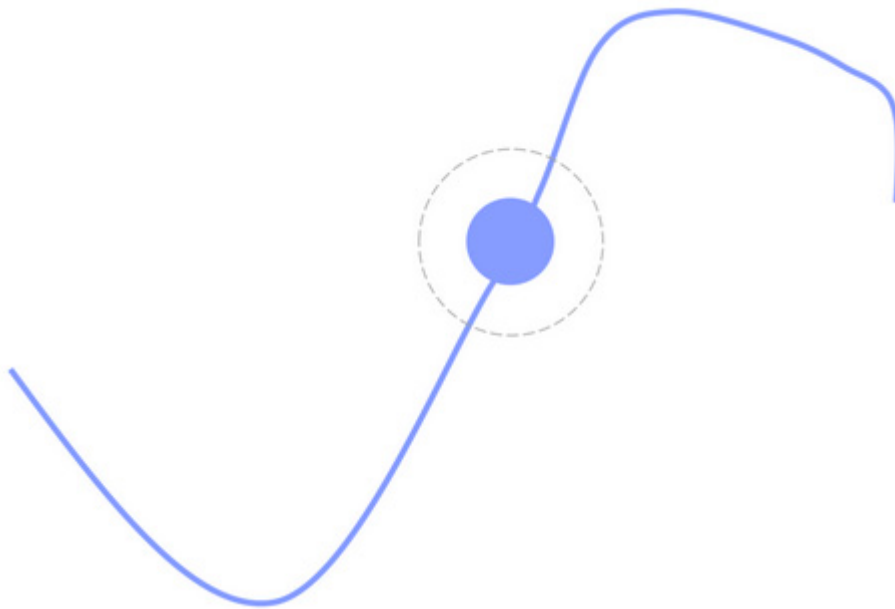


Figure 3

Any suitable algorithm may be employed for point collapse calculation (e.g., k-means algorithm (see <https://www.youtube.com/watch?v=RD0nNK51Fp8>)).

When a presenter hovers his cursor over a point for a long time (e.g., ten seconds), it is possible that his focus stays there, too. For example, if the presenter moves his cursor to a Payments table to indicate that he is going to talk about details of payments, and then he releases his mouse or touch pad, and begins to introduce that table. He may talk for a relatively long time (e.g., over ten seconds). Thus, the cursor stays in that single point for over ten seconds as well. In such a situation, the last point where the cursor has been staying is a prominent point which deserves viewer attention.

When the presenter performs a mouse event (e.g., single click, double click, mouse down, mouse up, etc.), this may indicate a region that deserves viewer attention. For example, the presenter may double click some text to draw the audience's attention. Therefore, when a presenter mouse event is detected by the meeting client, it is broadcast in meeting, and viewer's meeting client translates the cursor position as a prominent point.

When the presenter moves the cursor from one prominent point to another prominent point, the cursor may pass many middle points. It is obvious that the presenter does not intend to draw the audience's attention to each of these middle points. The only information that the presenter may want to express is that the cursor has been moved.

Therefore, there is no need to highlight each of these middle points. A fitting curve to pass through them is enough. These middle points are called transient points.

Figure 4 below illustrates an example of prominent points and transient points. At point 101, the presenter clicks the mouse, and thus point 101 is a prominent point. The presenter moves the cursor around point 102 repeatedly, and thus the points around point 102 collapse and are replaced with a single point 102, which is also a prominent point. Similarly, moves the cursor around point 103 repeatedly, and thus the points around point 103 collapse and are replaced with a single point 103, which is another prominent point. Finally, the presenter moves the cursor to point 104 and releases the mouse or touch pad before introducing details relating to point 104. The cursor remains on point 104 for longer than a threshold period of time (e.g., ten seconds), and thus point 104 is a prominent point as well. All other points are transient points, including t_{1-1} , t_{1-2} , t_{1-3} , t_{1-4} (collectively shown as points 111), t_{2-1} , t_{2-2} , t_{2-3} , t_{2-4} (collectively shown as points 112), and t_{3-1} , t_{3-2} , t_{3-3} , t_{3-4} (collectively shown as points 113). The four prominent points are rendered as solid circles while the transient points are rendered as a curve passing through them in the original sequence in which the transient points are produced.

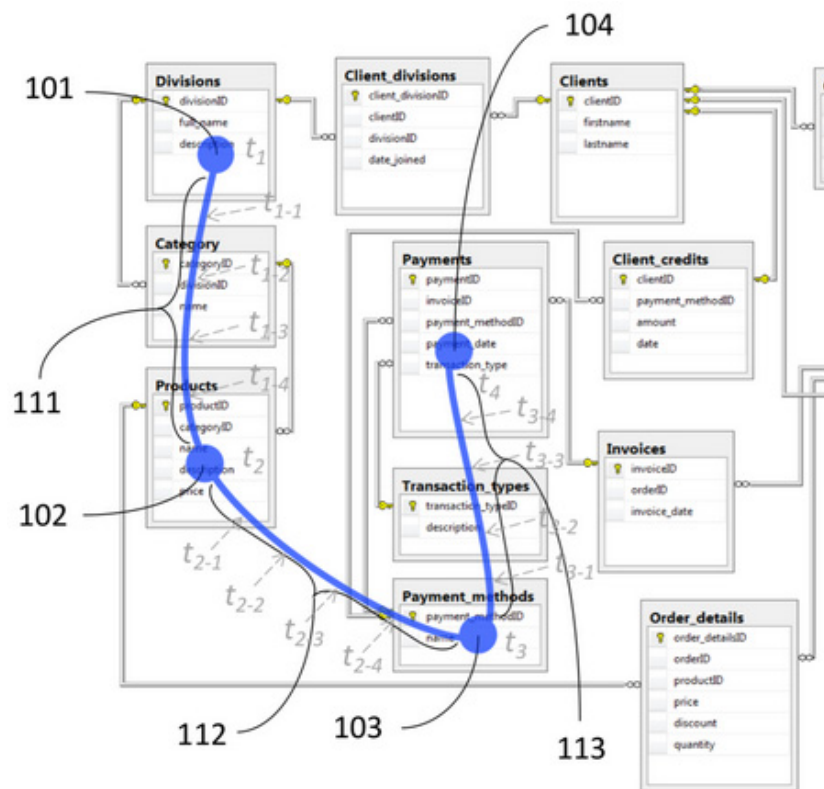


Figure 4

A color gradient may indicate the direction of the cursor trail. For example, as illustrated in Figure 5 below, a darker portion of the cursor trail may be more recent than a lighter portion of the cursor trail. And the cursor direction is always from the lighter side to the darker side.



Figure 5

There are two situations in which cursor trail may expire. First, an old cursor trail may expire when a new cursor trail is produced by the presenter. Second, a cursor trail may expire when the image beneath the cursor changes.

With respect to the first type of expiration, a cursor trail of unlimited length is actually meaningless, and therefore there is a threshold for the cursor trail (e.g., 50 pixels). If the current active cursor trail length is beyond that threshold, the tail portion may expire and disappear. There may be first in first out (FIFO) queue in each viewer's meeting client for the cursor trail. Whenever the presenter makes any cursor movement or mouse event, a new record may be pushed into this queue for each viewer.

Figures 6 and 7 illustrate the queue at t_8 and t_{11} , respectively. This is a dynamic process. On one hand, the presenter produces new cursor records, while on the other hand, the old cursor records expire and are discarded for the viewer. Cursor records in the active part of the queue is consumed by reviewer while the expired part is discarded. At any time in an online meeting, the cursor trail length may be equal to or less than a predefined threshold for better user experience. In one specific example, this threshold may be customized by the viewer manually.

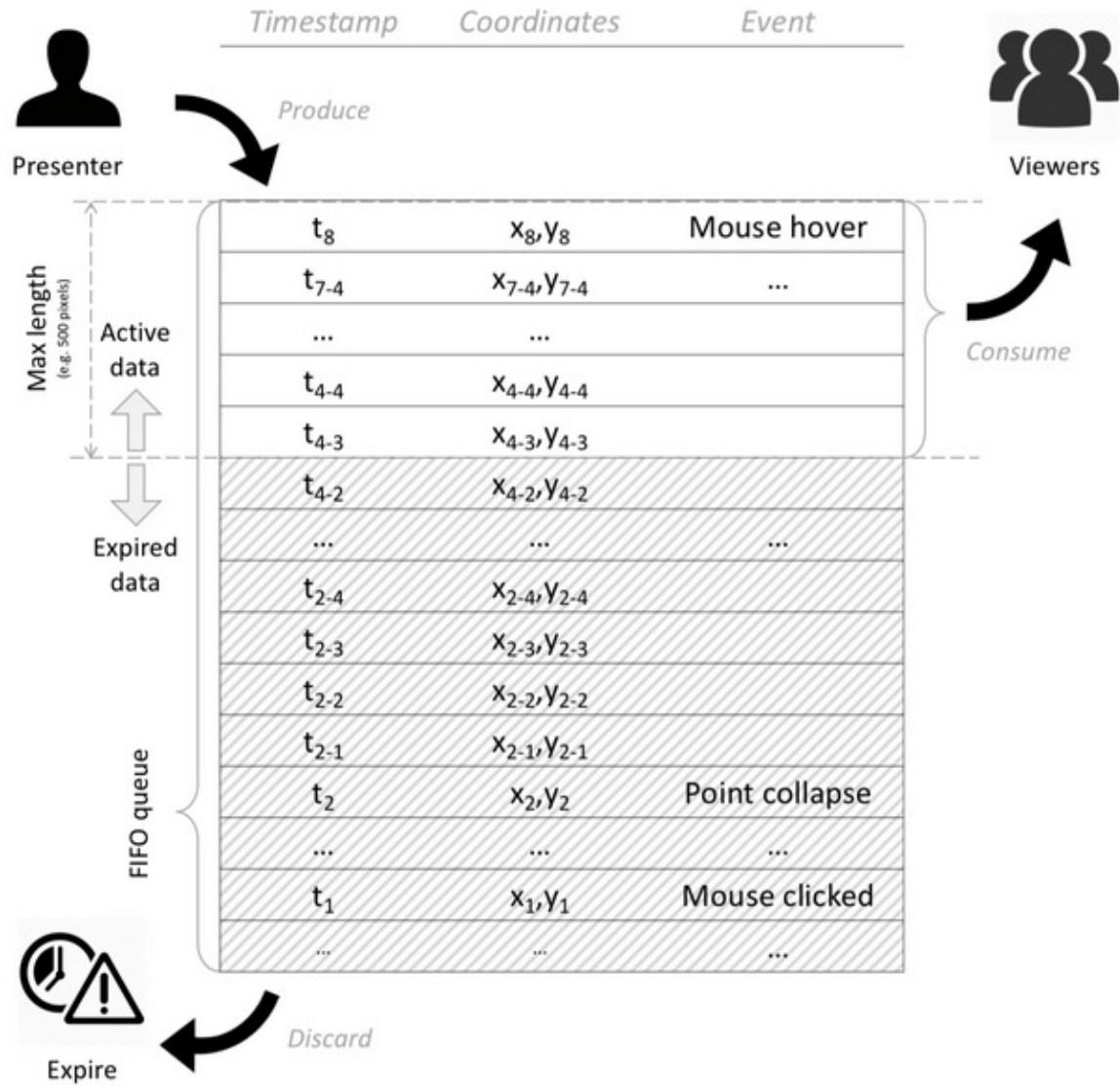


Figure 6

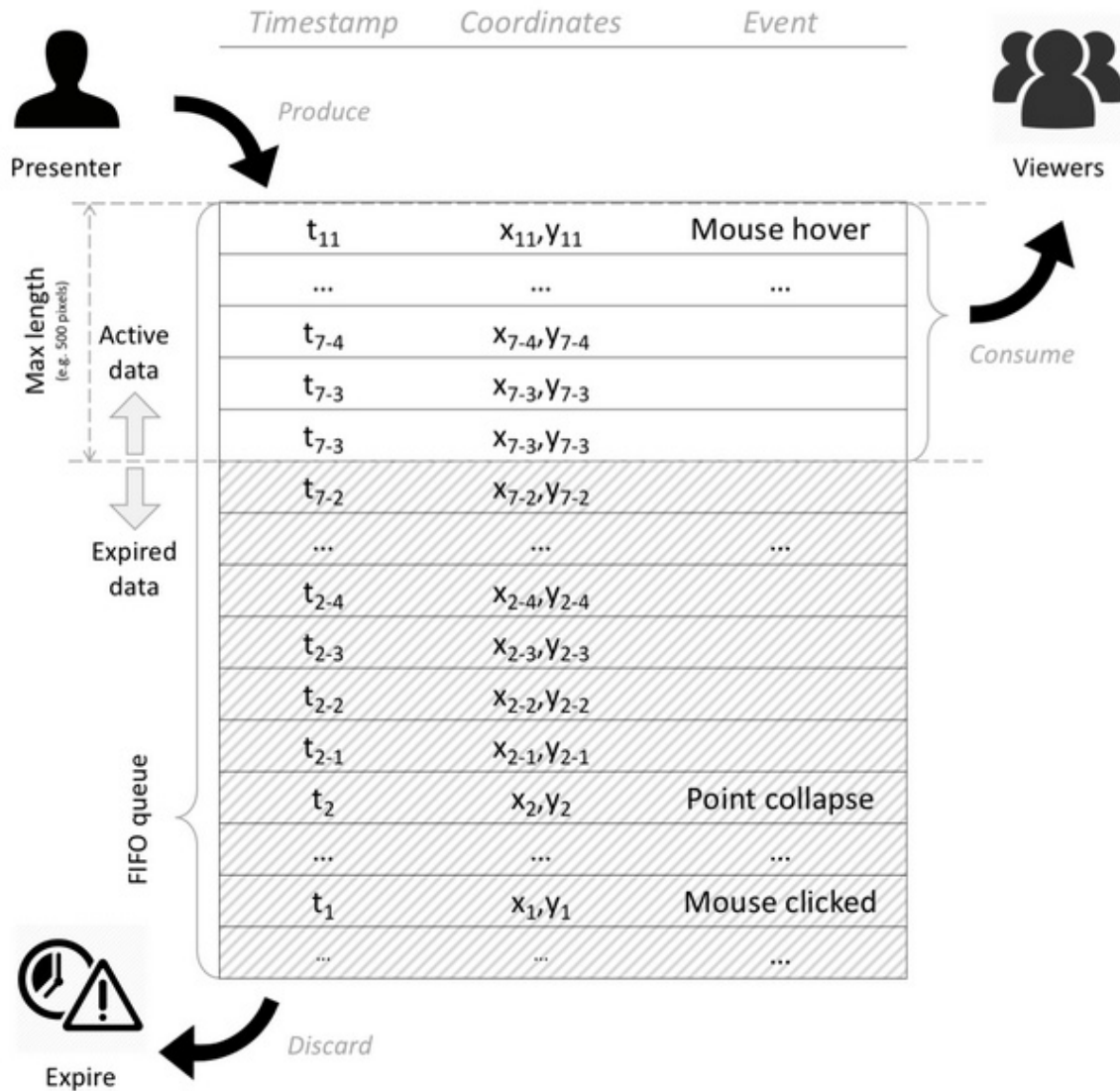


Figure 7

Figures 8-13 below illustrate cursor expiration in a period from t_4 to t_{11} . As time goes by, the presenter produces more and more cursor records including new cursor coordinates, mouse events, etc. These are pushed into the viewer’s FIFO queue and processed according to several rules. The first rule is that the tail part of the cursor trail disappears when the new trail is produced to ensure that cursor trail length is equal to or less than the maximum length. The second rule is that any knotting points collapse to prominent points automatically. This collapse also reflect in the FIFO queue. The knotting points in the FIFO queue are replaced with a single prominent point with the event of point collapse. The third rule is that any point at which the cursor stays for a long time (e.g., over

a threshold of ten seconds) is promoted to a prominent point automatically. The cursor trails shown in Figures 8-13 below are not to scale, and in reality would be equal in length.

Figure 8 below illustrates the cursor trail at t₄.

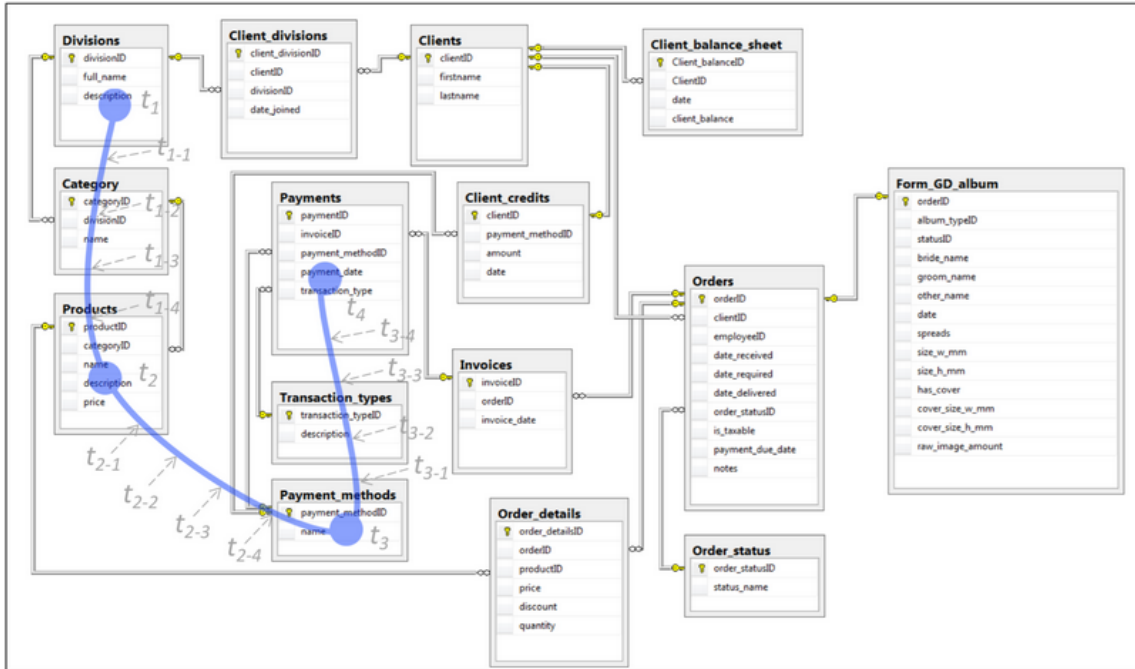


Figure 8

Figure 9 below illustrates the cursor trail at t₅₋₁.

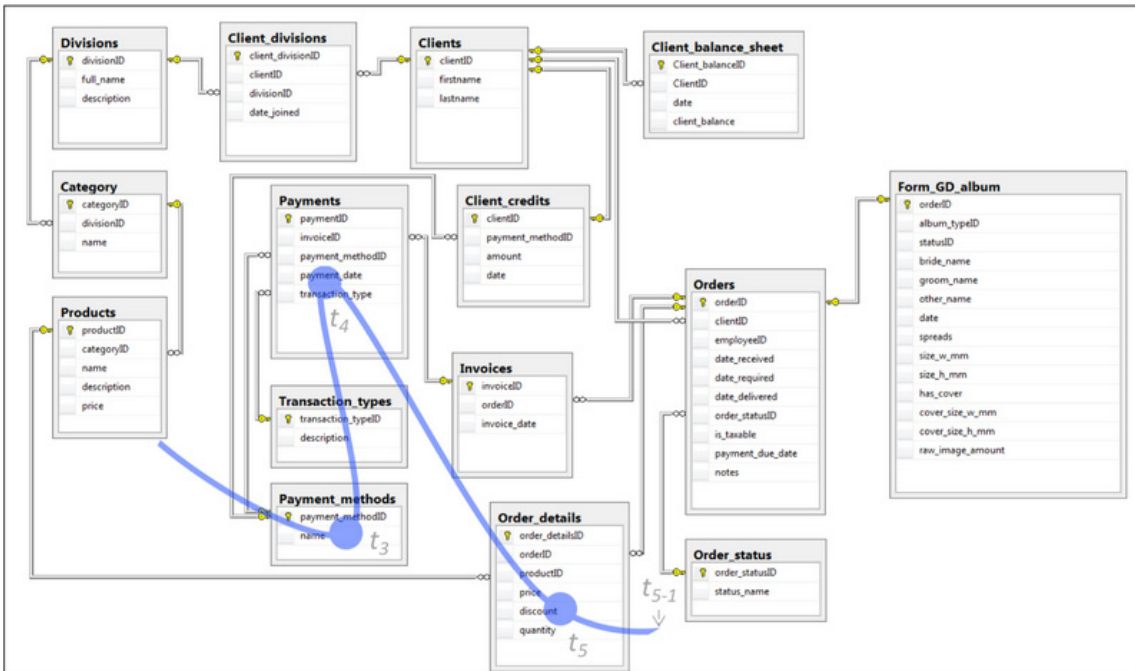


Figure 9

Figure 10 below illustrates the cursor trail at t₆₋₂.

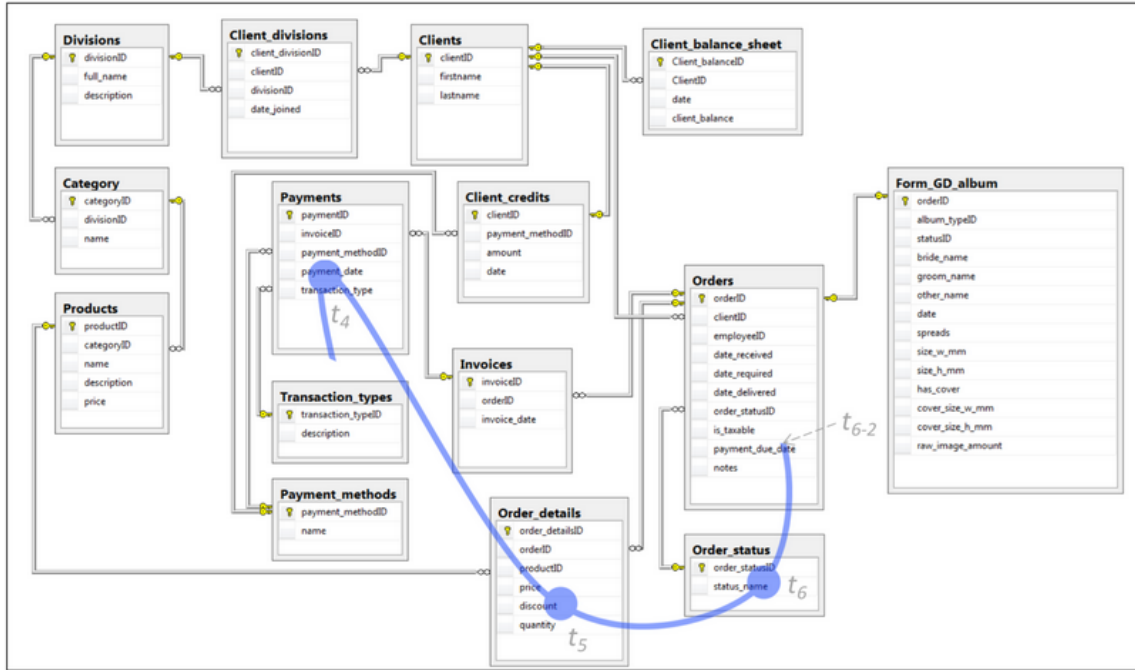


Figure 10

Figure 11 below illustrates the cursor trail at t₈.

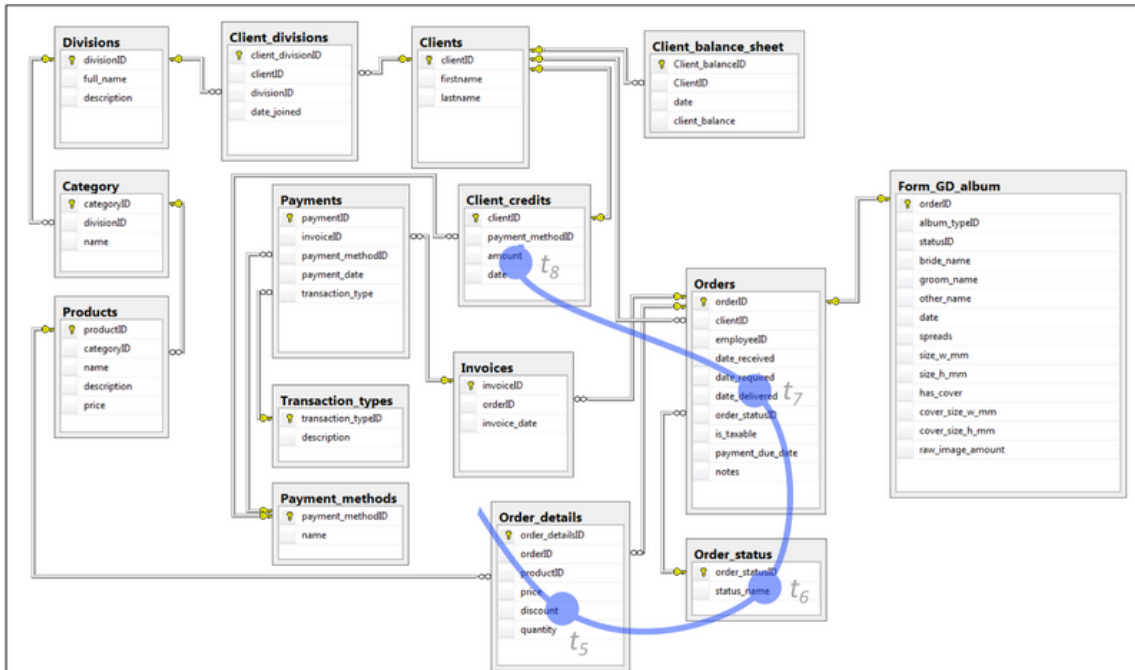


Figure 11

Figure 12 below illustrates the cursor trail at t₁₀.

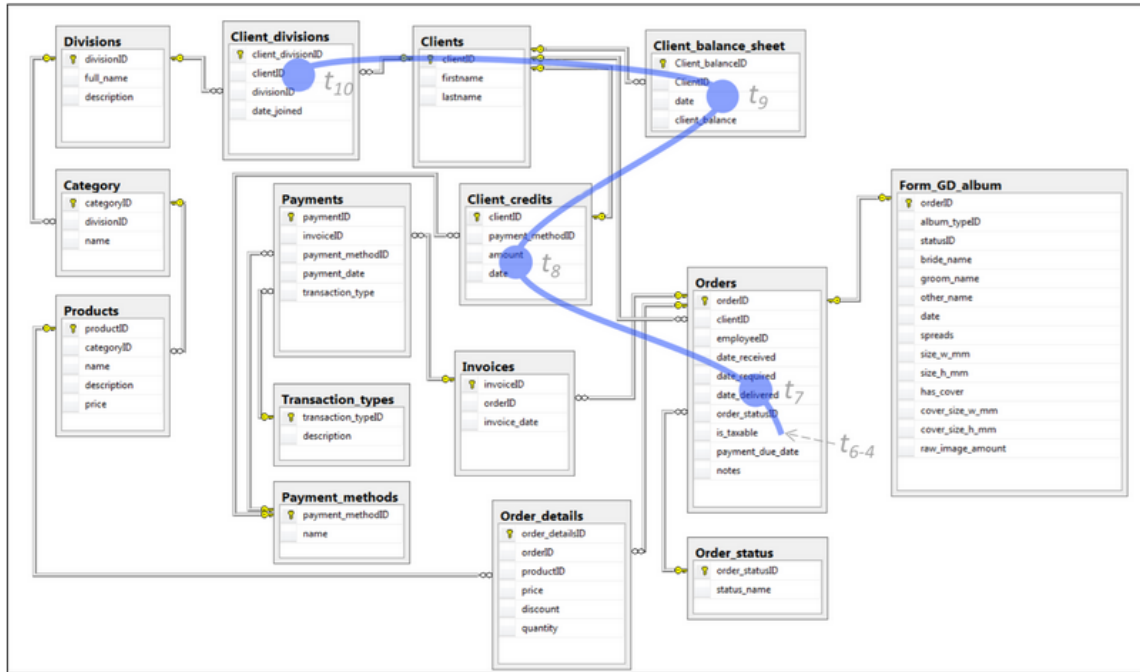


Figure 12

Figure 13 below illustrates the cursor trail at t_{11} .

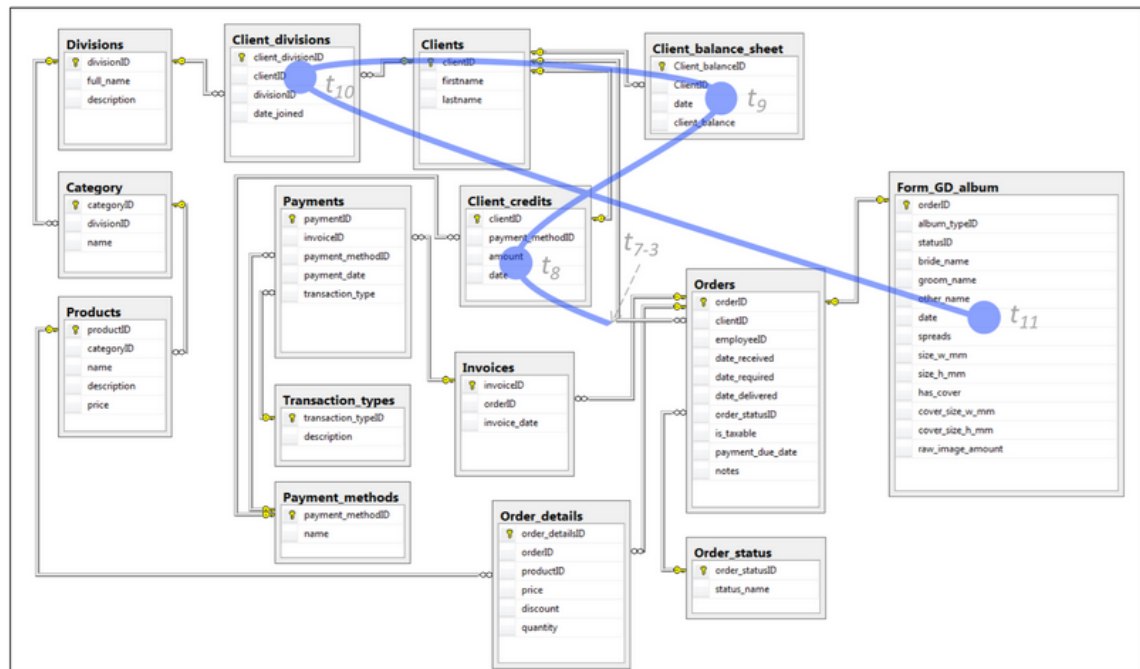


Figure 13

A second situation in which the cursor trail may expire is when the presenter's sharing content (e.g., the desktop or application being shared) changes. In this scenario, the image beneath the trail may change, and thus part or all of the trail may be out-of-date.

Here, the out-of-date part of cursor trail may expire and disappear immediately. Older portions of the viewer's cursor trail may fade out when the presenter produces new cursor trails. In this dynamic process, the viewer's cursor trail remains constant in length. The cursor trail disappears or fades out when it becomes out-of-date when the image beneath the cursor changes.

Figures 14 and 15 below illustrate an example of the second type of cursor trail expiration. The green blocks represent which parts of the sharing content have changed. In Figure 14, at timestamp t_8 , the cursor trail points which are nearest to blocks of b_1 and b_2 are out-of-date. Thus, the tail part of current trail through point t_{5-3} should expire and disappear immediately.

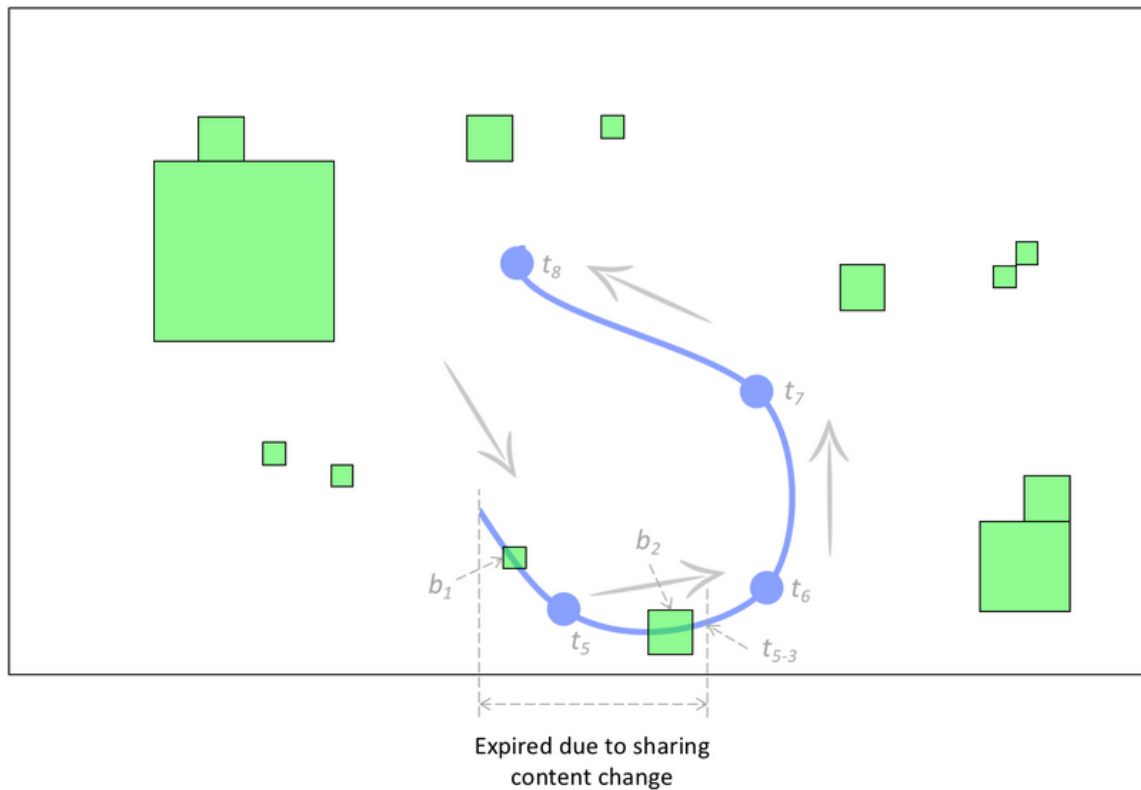


Figure 14

Figure 15 illustrates the cursor trail after expiration at t_8 .

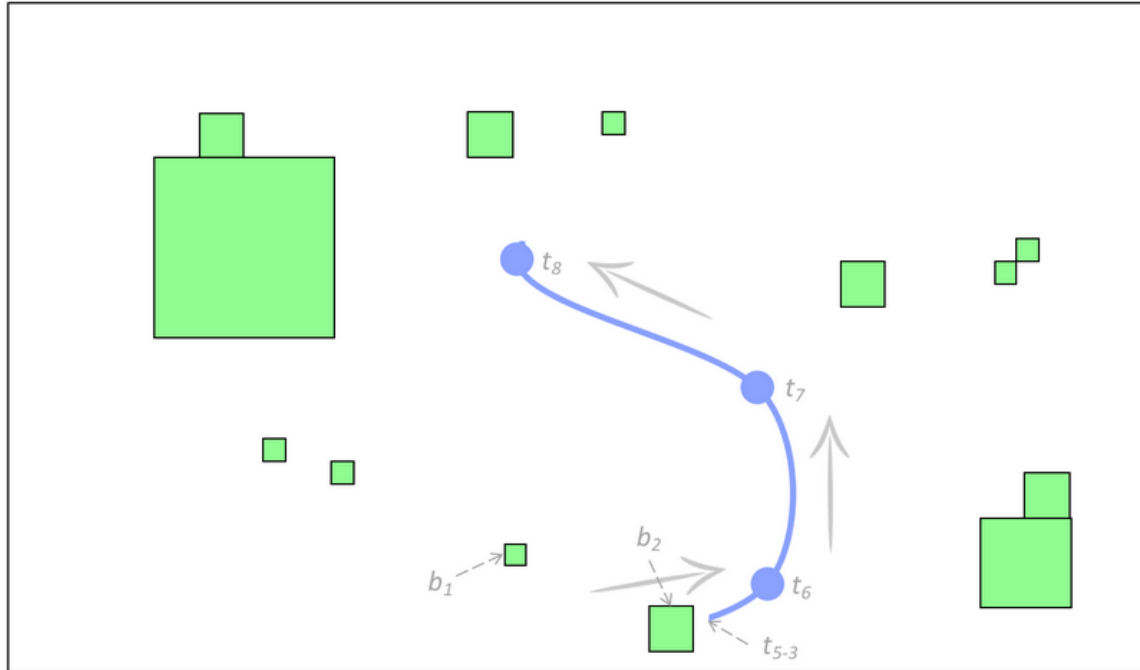


Figure 15

Figures 16 and 17 illustrate another example of cursor trail expiration for a different sharing content change. In this example, the blocks that changed have different positions than those in Figures 14 and 15. Figure 16 illustrates the cursor trail points that are nearest to blocks b_3 , b_4 and b_5 are out-of-date. Thus, the tail part of current trail through point of t_{6-2} should expire and disappear immediately.

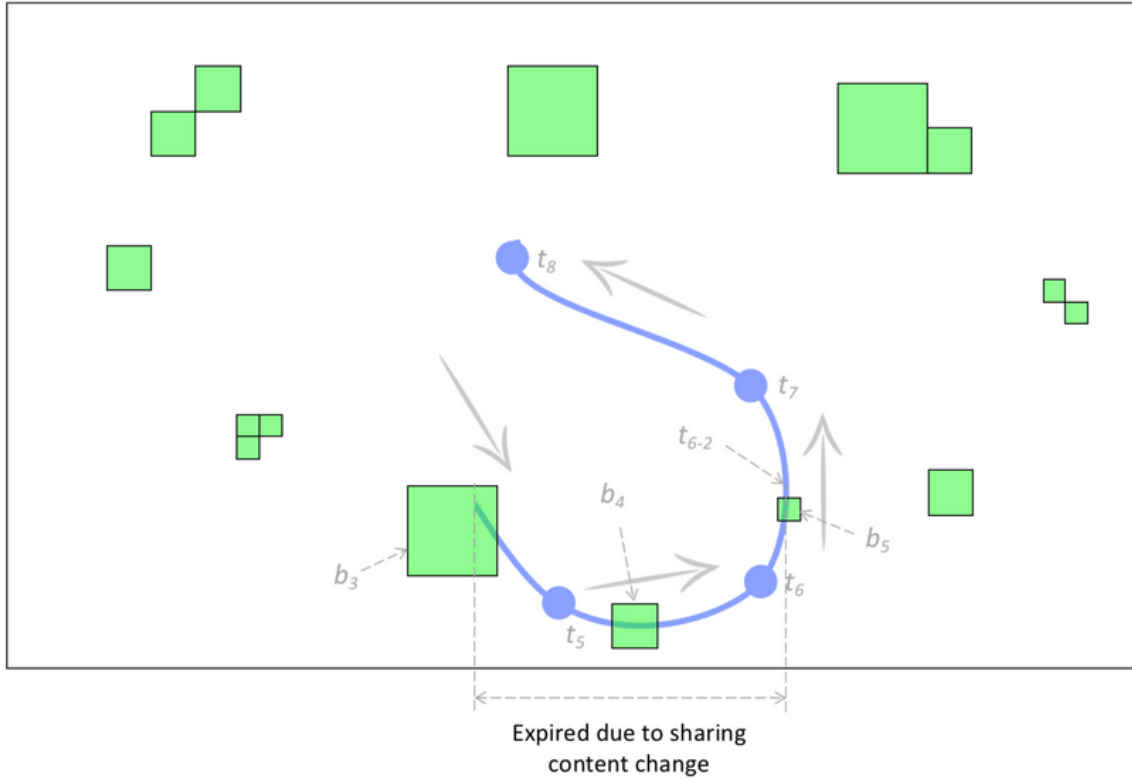


Figure 16

Figure 17 below illustrates the cursor trail after expiration at t_8 .

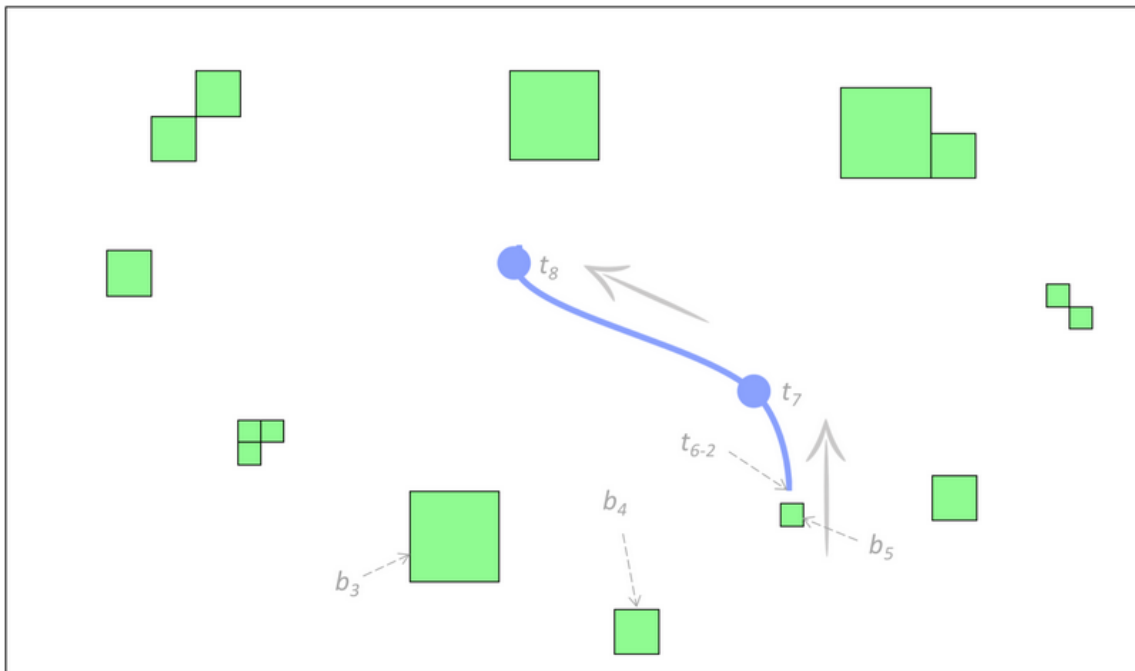


Figure 17

Expiration detection may be performed in the event of sharing content change at a reasonable frequency. The event of sharing content change may be detected by interception of the video codec. Whenever an update is required for current frame, the information of the changed blocks (e.g., the green blocks in Figures 14-17) may be retrieved from the video codec. By calculating the FIFO queue and the changed blocks, the meeting client may determine which part of the current trail is to expire and then cause that part to disappear.

In addition to providing cursor trail indication in an online meeting in real time, the techniques described herein may also employ the cursor trail in a meeting recording playback. The FIFO queue information may be stored as a separate file (e.g., “meeting.trl”) which is similar to lyric and subtitle files. This file may associate with the meeting recording file based on timestamp alignment. When the meeting recording is played back, the player may retrieve cursor trail information around the current timestamp from meeting.trl, and calculate and render the cursor trail in a similar manner to cursor trail calculation and rendering in a real-time meeting.

The cursor trail may also be merged into a meeting recording video stream without requiring any extra files or functions of the recording player. Depending on the specific implementation of the online meeting vendor, the cursor trail may serve as a separate file or be merged into the video stream. A new user experience for meeting recording users is thus provided. With the cursor trail rendered in the meeting recording playback, the user may quickly and easily catch up with meeting presenter’s focus. This adds value to the meeting recording itself, and significantly improves the productivity of meeting playback.

In summary, techniques are described to intelligently display a presenter’s cursor trail in an online meeting to enable all attendees in the meeting to easily recognize which part of shared content the presenter has recently discussed and/or is currently discussing. These techniques are completely automatic and therefore require no extra effort for the presenter or the attendees. The cursor trail is so tidy and intelligent that a convenient user experience is guaranteed. Productivity of collaboration in online meeting can thus be significantly improved.