Global Delivery Architecture to Enhance Scene Viewing UX

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Due to the vast amounts of video on demand (VOD) service content, scene viewing, in which users select only scenes they want to view within short amounts of time, is expected to go mainstream in the future. Conventionally, global delivery of VOD has used content delivery networks (CDN) to reduce latency (time delays in communication generated during data transfers) in viewing. With scene viewing, however, the huge number of search patterns has caused lower cache hit ratios on CDNs, making it difficult to reduce latency. For the delivery of FUJITSU Business Application Operational Data Management & Analytics PITCHBASE, a scene viewing service specialized in professional baseball videos, to users overseas, Fujitsu has developed a video delivery architecture independent of CDNs and is working toward its realization. This architecture is capable of quickly providing scene viewing even to users overseas by releasing viewable scenes in stages while deploying baseball videos, which are increasing on a daily basis, outside Japan and reducing latency. This paper describes this delivery architecture, which enhances user experiences (UXs) in scene viewing globally.

1. Introduction

In video viewing, the time spent on watching Internet videos and recorded programs has been increasing, reflecting an increase in the number of people watching videos at a time convenient for them.[1] Subscribers to video on demand (VOD) services are also expected to increase.[2] In providing VOD services, the focus for providers so far has been on playback technology to achieve video viewing with no waiting or interruptions. However, with the introduction of large amounts of content, it is becoming increasingly important to achieve "scene viewing" tailored to user preferences, that is, to enable efficient viewing of only those scenes that the user wishes to watch within a limited amount of personal viewing time.

Fujitsu provides FUJITSU Business Application Operational Data Management & Analytics PITCHBASE (hereafter, ODMA PITCHBASE) as a scene viewing service operating on the cloud. ODMA PITCHBASE combines the video of professional baseball games and the data obtained during play to enable rapid searching and analysis of game video anytime and anywhere.

In this service, the user can switch between video scenes obtained by searching. However, if reading in video when switching scenes generates wait time, viewing comfort will suffer and the user experience (UX) will deteriorate. For this reason, we developed technology for reading in the video of searchable scenes beforehand with the aim of reducing the playback wait time when switching scenes, thereby enhancing the UX when viewing video.

In scene viewing, however, there is much more video that can be targeted for searching than those in standard VOD services, so even the use of a content delivery network (CDN) traditionally used for global delivery of VOD cannot achieve a cache-based reduction in latency (delay time associated with data transfers). In scene viewing on a global basis, this means that reading in video takes time, which makes it impossible to maintain a heightened UX in a global environment as achieved within Japan through pre-reading technology. Consequently, to promote delivery to overseas users, Fujitsu has proposed a global delivery architecture independent of CDN.

In this paper, we first describe the system configuration of ODMA PITCHBASE and the issues associated

with global delivery in scene viewing. We then describe the global delivery architecture for solving those issues.

2. System configuration of ODMA PITCHBASE

This section describes the system configuration of ODMA PITCHBASE. The system is implemented on a server located in Japan using a cloud service. It handles the following types of data, which are registered by the process flow shown in **Figure 1**.

1) Baseball data

These data, which can be referenced by all users, are input by the operator.

- Game data: Game day and time, results, etc.
- Pitch event data: Event information consisting of pitch and result (ball, strike, hit, etc.) input by the operator in real time
- Master data: Information on players, teams, etc. that can be updated on a player's transfer to another team, etc.

2) Inning video data

Video data of a game's inning are registered in the system in units of innings as MP4 video files and converted to the HTTP Live Streaming (HLS) format. HLS consists of a segmented file group that divides the video into fixed time intervals and a playlist file containing the file paths to those files in playback order. Although the size of this playlist depends on the total length of the video and the time interval used for segmenting, it is still smaller than a typical video segment.

3) Scene search data

These data consist of single-pitch data generated after video registration and search data tied to the video. They include pitch information and inning video information (playlist storage destination and playback start/end locations).

Scene viewing is also provided as the game progresses in units of innings. Scenes within an inning can be viewed within 20 minutes after that inning completes.

In scene viewing, the application sends a query to the Web server on the basis of the search conditions input by the user and searches scene search data. It then obtains the video tied to the retrieved scene search data from the video delivery server and proceeds to play it (**Figure 2**). This video playback process makes use of the HLS playlist and the HLS segmented files containing scenes. It also achieves comfortable scene viewing through technology that shortens the playback wait time when switching scenes.

3. Issues in global delivery of scene viewing

The provision of ODMA PITCHBASE to overseas users is now moving forward. In general, global delivery of video will apply a CDN that uses cached content

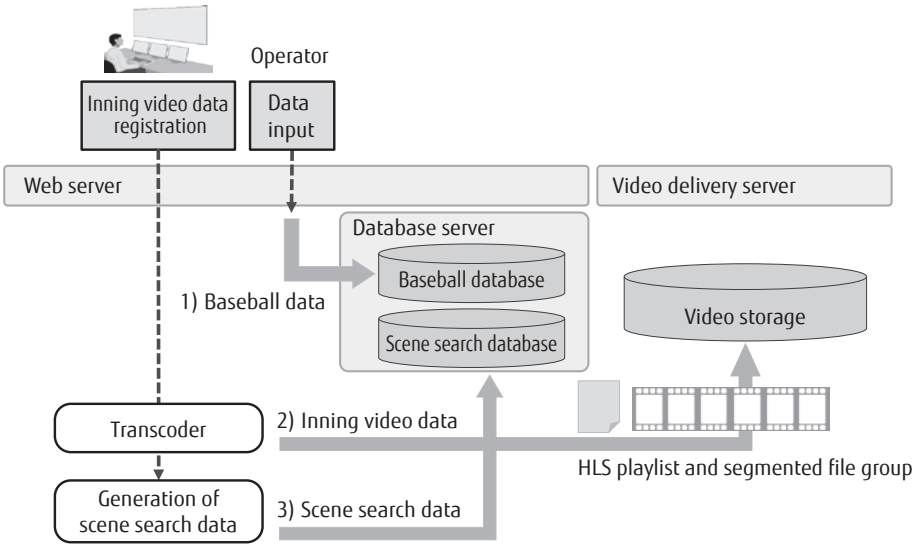

Figure 1
Flow of data registration.

on an edge server (cache server for video content) near the user to reduce latency in video delivery. In a standard VOD service, a user will search for and watch specific video programs, so videos can be efficiently cached in accordance with access frequency.

In scene viewing, however, video files differ for each scene resulting in many video files that become search targets. As a result, the cache hit ratio of CDN in scene viewing is low compared with that of standard VOD, that is, CDN's effect in scene viewing is small. More time is therefore needed to play back a scene overseas.

To give an example, we consider a user in Japan using a CDN having an origin server (server that stores original video content) in the United States. When the user wishes to view a scene and no content has been cached on an edge server located in Japan, it will be necessary to obtain the desired content from that origin server in the United States. As a result, it will take about five times as long to play back a scene compared with the case of content cached on an edge server in Japan.

Furthermore, latency can be high if data for scene searching is stored at a location geographically far from the user. Consequently, in existing architecture that uses a CDN, a large difference occurs between Japan and overseas scene viewing in the lead time required from scene searching to video playback. This means that scene viewing at overseas locations cannot provide the same viewing environment as in Japan.

4. Issues in duplicate placement of video and scene search data

To reduce latency in overseas scene viewing, video data and scene search data must be stored on servers in an overseas base without depending on CDNs so that performance equivalent to that in Japan can be maintained. However, considering that the time taken to transfer video data is relatively long compared to that of scene search data, placing both types of data overseas at their respective times of registration means that scene search data placement will be completed first, leading to a situation in which searching can be performed but video viewing cannot.

On the other hand, if scene search data were to be placed after duplicating and placing video data in units of innings or games, an additional amount of time would be required for the provision of scene viewing compared with that in Japan. In this regard, we point out that applications of scene viewing, especially in relations to sports, will expand to be closer to such services that operate in real time. One example would be an application that allows users to review favorite scenes immediately after a live broadcast. For this reason, the above time lag is an issue that needs to be addressed for future business development.

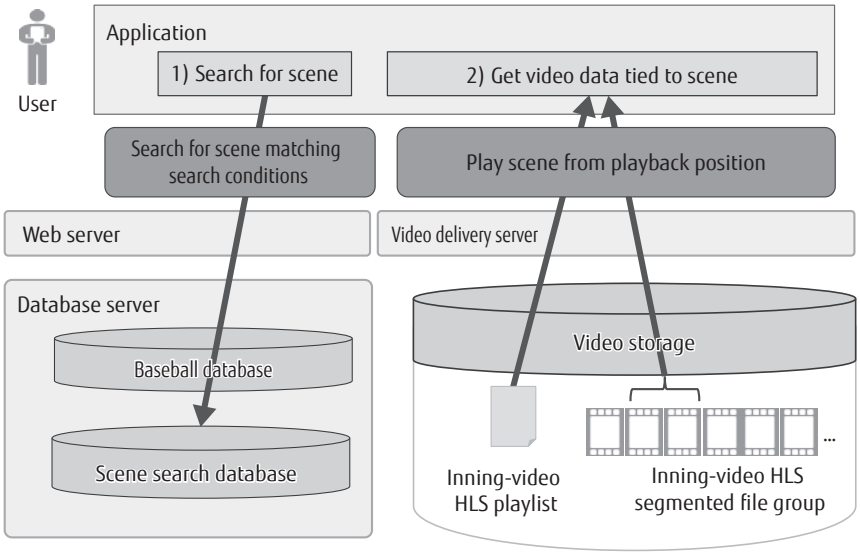

Figure 2
Scene viewing mechanism.

Accordingly, while it is necessary to place scene search data and video data on servers at an overseas base as quickly as possible, some type of release control is needed to disable searching of scenes whose video data is not yet ready for viewing.

5. Global placement architecture for scene viewing

We describe an architecture that, in addition to reducing latency, can perform duplicate placement of scene search data and video data at an overseas base as quickly as possible thereby providing users with comfortable scene viewing (**Figure 3**).

The duplicate placement requires that a method be selected that takes the characteristic features of these data into account.

1) Placement of baseball data

It must be possible to reference baseball data at another base without having to wait for the video data placement. For this reason, performing duplicate placement of baseball data immediately after input using a database replication function is the best method from the viewpoint of development cost and speed.

2) Placement of video data

For the case of servers that are geographically distant from each other, the best method for video data placement from the viewpoint of development cost and speed is to perform duplicate placement immediately after registration in storage using inter-region replication provided by a cloud service.

3) Placement of scene search data

Placing duplicated scene search data enables the possibility of completing placement before video data in the same way as baseball data. With this in mind, the method chosen here is to place the scene search data in storage as a data file simultaneously with saving it in a database at the time of its generation and to then perform inter-region replication in the same way as the video data. This approach can achieve high-speed placement of scene search data without the need for preparing a special transfer method. At this time, release control will be performed before the placement of scene search data to synchronize with the associated video data by enabling or disabling the release of that data.

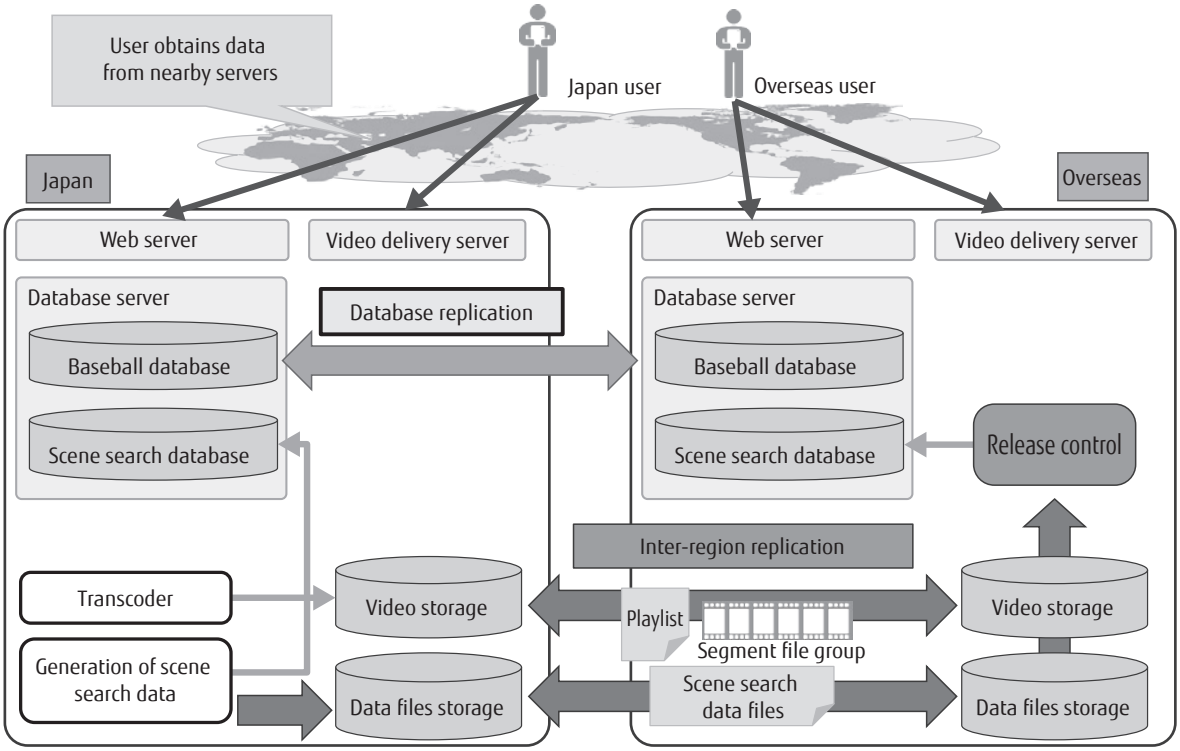

Figure 3
Duplicate placement architecture for overseas bases.

6. Release control of scene search data

We describe a data release control mechanism to solve the issue that arises in the duplicate placement of scene search data at an overseas base (the situation in which the user can search for but cannot view video).

The placement-destination base receiving the scene search data through inter-region replication detects when a data file has arrived by using a cloud-service function that detects a storage file-update event. The mechanism then reads this newly arrived data file and stores it in the scene search database (**Figure 4**). However, if there is no video data corresponding to this scene search data at this stage, it sets the data's status flag to "non-release" to disable searching.

Furthermore, as part of this mechanism, a release-management batch program periodically checks whether video data corresponding to scene search data whose status flag is set to "non-release" has arrived, and if so, changes the status of that data to "release" to enable searching. To determine whether video data corresponding to a scene has arrived, the mechanism first identifies the segmented file corresponding to that scene by using the playlist storage destination and playback start/end locations contained in the scene search data. Moreover, in the event that the segmented file group corresponding to the scene search data is complete, the mechanism releases the scene search data (**Figure 5**). This mechanism uses a function of the scene-video pre-reading technology described above in "System configuration of ODMA PITCHBASE" that enables an inning video to be read and played back in units of segmented files even if placement of the video for all of that inning from start to finish is not yet complete. In short, this mechanism enables progressive scene searching during the time that video files are being placed on a scene-by-scene basis before all of the inning video including those scenes has been placed.

7. Effects

We describe the effects of applying the global delivery architecture described above to scene viewing from a user perspective and the effects expected from a business point of view.

1) Effects on users

The application of this architecture can eliminate

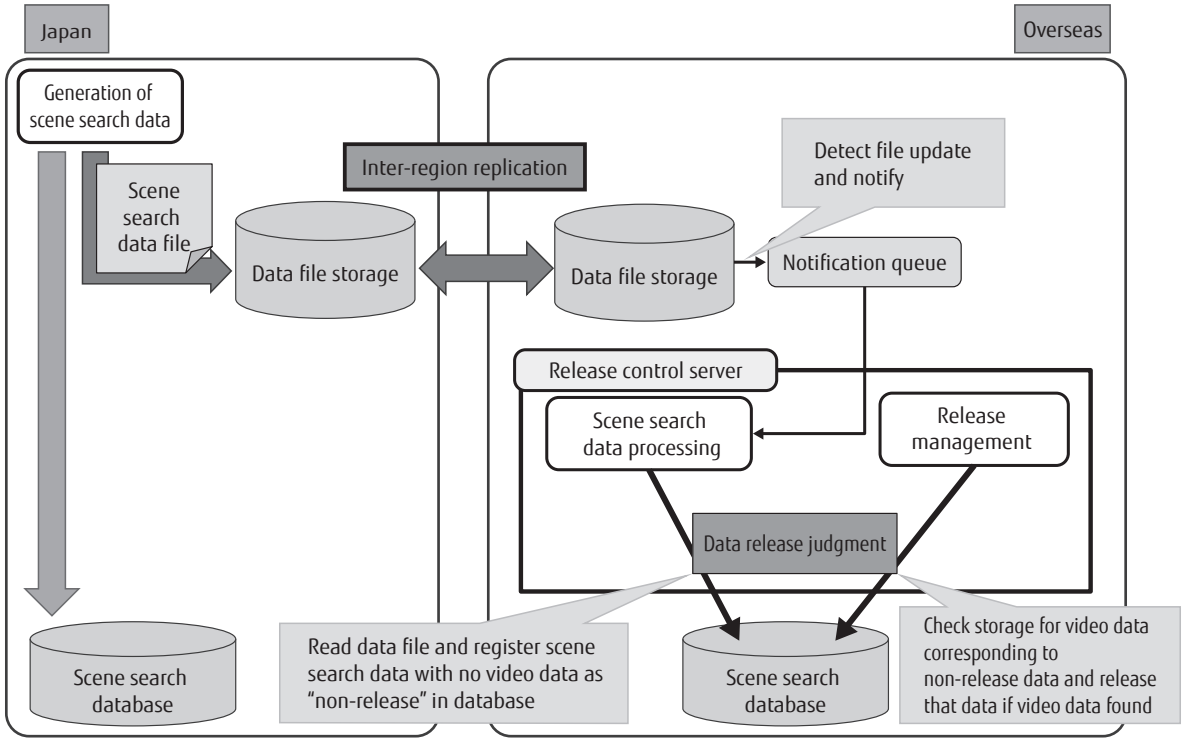

Figure 4
Replica placement of scene search data.

latency in scene searching and video playback and can provide overseas users with a viewing environment equivalent to that of Japan. This makes it possible to enhance the UX through pre-reading technology even for overseas users.

Additionally, once video data is registered in Japan, the process of video delivery is immediately initiated. Between Japan and the United States, video delivery can be completed in 1–2 minutes for about 100 MB of inning video footage (average size for a video file). However, this delivery time depends on a video's file size. Additionally, the process of placing scene search data can save the equivalent of 20 pitches worth of data in the destination database within 20 seconds, enabling viewing to proceed progressively from releasable scenes.

Consequently, as segmented video files begin to arrive 20 minutes after the completion of an inning (the time it takes for an inning video to become viewable in Japan), the process of releasing data overseas begins within several minutes at the most, resulting in only a small time difference in the provision of scene viewing between Japan and the United States.

2) Expected effects on business

Looking forward, we can envision the provision of scene viewing in Japan to be available closer to a live broadcast by using even finer units of video such as batters and pitches in place of innings as currently used. The architecture proposed in this paper will enable the early provision of such a system overseas. In other words, it will enable global expansion of scene viewing while watching a live broadcast in the manner of "I want to see an earlier scene one more time" or "I want to see that scene that I missed right away." Given the wide variety of viewing formats particularly in sports having large markets with worldwide viewing, the proposed architecture should have a big impact on expanding future businesses fusing "world sports" with "various viewing styles."

8. Conclusion

We described a global delivery architecture to solve the problems associated with overseas delivery of scene viewing. This architecture is the result of a study that focused on enhancing the UX on the basis of scene-viewing know-how and solutions previously accumulated by Fujitsu in services targeting professional baseball. We are currently working on enhanced control techniques for releasing data. Going forward, we aim to achieve diverse forms of viewing styles in addition to a global rollout of scene viewing for sports.

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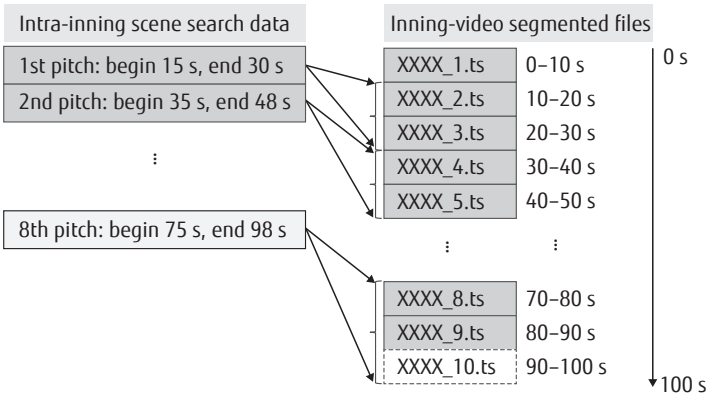

Figure 5
Mechanism of judging data release.

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