

Local Storage Sample

*This sample is compatible with the Microsoft Game Development Kit (June 2020)*

# Description

This sample shows how to use different local storage locations in a title for both console and PC platforms. In addition, the sample also shows how some extra behavior related to local storage works for consoles.

# Building the sample

If using an Xbox One devkit, set the active solution platform to Gaming.Xbox.XboxOne.x64.

If using an Xbox Series X|S devkit, set the active solution platform to Gaming.Xbox.Scarlett.x64.

If using Windows 10, set the active solution platform to Gaming.Desktop.x64.

*For more information, see* Running samples*, in the GDK documentation.*

# Using the Sample

Launch the sample from Visual Studio and use the sample’s interactive buttons to run different test cases. Switch the current storage location using the left and right arrow buttons in the sample. Available test cases change depending on platform and selected storage type.

PC:

Text

Description automatically generated

Console:

Text

Description automatically generated

# Implementation Notes

The sample allows for testing different storage behaviors with the different local storage options.

## Local Storage Options

There are several different local storage options on console and numerous options on PC. All console options are covered in this sample. However, the PC coverage is limited to the most common usages.

Storage Options by Platform:

|  |  |  |
| --- | --- | --- |
| Storage Option | Console Availability | PC Availability |
| Persistent Local Storage (PLS) | **Yes** | **Yes\*** |
| Temp Drive (T:\) | **Yes** | No |
| Installed Game Data (G:\) | **Yes** | No |
| System Scratch Drive (D:\) | **Yes** | No |
| TEMP Folder | No | **Yes** |
| LocalAppData Folder | No | **Yes** |

*\*PLS storage space on PC is not specifically provisioned or managed for a title beyond deletion when the title is uninstalled.*

*Note: For a more complete listing of built-in local storage locations on PC, see* [*SHGetKnownFolderPath function (shlobj\_core.h) - Win32 apps | Microsoft Docs*](https://docs.microsoft.com/windows/win32/api/shlobj_core/nf-shlobj_core-shgetknownfolderpath)*. A list of known folders can be found here:* [*KNOWNFOLDERID (Knownfolders.h) - Win32 apps | Microsoft Docs*](https://docs.microsoft.com/windows/win32/shell/knownfolderid)*.*

**Persistent Local Storage (PLS)**

PLS is a long-term storage location for storing non-game-save data. Common usages might include generated cache data, replay storage, or User-Generated Content (UGC) storage.

PLS on console platforms have the following characteristics:

* Title specific: This storage space can be accessed by the title that requested it only.
* Console-specific: This storage space is always created in an XVD which is specific to the console (even if the title is installed on an external drive) and cannot be used on another console.
* Guaranteed allocation: The system ensures that the space is allocated prior to the title being allowed to launch. If insufficient hard drive space is available, the user is prompted to free up space to allow the title to run.
* User-controlled: The storage space can be deleted by users from the system shell. The system never automatically deletes any items in the space.
* Tied to title install lifetime: When a title is uninstalled, the associated local storage space is removed too. If the title is re-installed, none of the previous existing data is restored.
* Resilient and tamper resistant: The storage space is encrypted and integrity checked so that the data saved by the title cannot be tampered with.

PLS on PC however does not provide the above guarantees. The location returned by PLS is a normal storage location on the device and will be deleted if the title is uninstalled.

To use PLS, it must be enabled in the MicrosoftGame.config file:

<?xml version=**"1.0"** encoding=**"utf-8"**?>

<Game configVersion=**"0"**>

<PersistentLocalStorage>

<SizeMB>**1024**</SizeMB><!-- Required Minimum Allocation Size -->

<GrowableToMB>**20480**</GrowableToMB><!-- Max Growable Size -->

</PersistentLocalStorage>

</Game>

The *SizeMB* parameter specifies the minimum allocation size that console platforms will ensure is always available for the title’s install. Remember than PC does not specifically manage the PLS storage space, so size availability is not guaranteed there.

The *GrowableToMB* parameter is optional and allows specifying a max growable size. PLS supports growing its allocation on consoles up to the max specified size. While the *SizeMB* is a minimum guarantee, the growable max size might not always be available. A title can grow its current PLS size if needed using *XPersistentLocalStoragePromptUserForSpaceAsync.* This action will prompt the user to free up hard drive space to make space available to grow PLS.

**Temp Drive (T:\)**

Consoles have access to a special temp drive access with the drive letter ‘T’. This drive has the following specifics:

* Maximum 2GB storage
* Guaranteed to be accessible and persistent while the title is running and across suspend/resume boundaries
* Deleted once the title is terminated

*Note: Previous Xbox Development Kit (XDK) behavior allowed the temp drive to persist often across launches. However, it still wasn’t guaranteed to persist. With the Microsoft Game Development Kit (GDK), PLS is offered as the persistent storage solution and the Temp Drive does not persist.*

**Installed Game Data (G:\)**

A special drive letter ‘G’ is offered on console builds to access the installed game data. This drive is read-only for packaged builds.

*Note: For development purposes, a title can write to the installed game data for loose builds only. However, it’s not recommended to do so as the other local storage options will likely be more suitable.*

**System Scratch Drive (D:\)**

Devkits have special access to a system scratch drive with the drive letter ‘D’. This development-only storage location allows writing anything needed for development purposes. A common usage might be developer logs, crash dumps, or other non-retail-purpose data.

The system scratch drive is persistent, has no limit on writing, and can be accessed by any title. It writes directly to the hard drive, so it can take up space needed for package installation.

This drive can also be accessed directly by a development PC via a network path “\\[DevkitIP]\SystemScratch” or by using “Browse Console Files” when right-clicking on a devkit in the Xbox One Manager tool.

**TEMP Folder**

On Windows PCs, the TEMP folder is used by many applications to store temporary data. This location is determined by the current user’s TMP/TEMP environment variables.

To get the TEMP folder, use the [GetTempPath](https://docs.microsoft.com/windows/win32/api/fileapi/nf-fileapi-gettemppatha) method.

**LocalAppData Folder**

The LocalAppData folder on Windows PCs is commonly used by applications to store per-user persistent application data that’s not included with an application installation.

To get the LocalAppData folder, use the [SHGetKnownFolderPath](https://docs.microsoft.com/windows/win32/api/shlobj_core/nf-shlobj_core-shgetknownfolderpath) method and with the FOLDERID\_LocalAppData parameter. Information on available known folders is documented at [KNOWNFOLDERID (Knownfolders.h) - Win32 apps | Microsoft Docs](https://docs.microsoft.com/windows/win32/shell/knownfolderid).

## Test Cases

There are several different test cases that can be run for each storage type. The available tests changes depending on platform and storage type.

Tests cases:

|  |  |
| --- | --- |
| Test Case | Description |
| Get Write Stats | *Console-only*: Reports on the title’s writing behavior to a tracked drive (PLS or Temp Drive). |
| Get Storage Info | Reports some basic information about the currently selected storage type, such as the path to use or how many files/folders are at the root location. |
| Query Free Space | Queries and reports how much free space is available on the currently selected storage type. |
| Write File | Attempts to write a file using the currently selected storage type. |
| Read File | Attempts to read a file using the currently selected storage type. |
| Get PLS Info | *Console-only*: Returns information about the PLS storage partition, including space used, available, max, and more. |
| Fill Available PLS | *Console-only*: A stress test to fill-up PLS at the maximum rate allowed via [XR-133](#XR133). |
| Stress Write Stats | Console-only: A stress test to write 2GB of data to the currently selected storage type at the maximum rate allowed via [XR-133](#XR133). |

**Get Write Stats Test Case**

This console-only test uses *XPackageGetWriteStats* to report on the writing behavior of the title. *XPackageGetWriteStats* returns the following information:

|  |  |
| --- | --- |
| Stat | Description |
| Interval | Total amount of milliseconds for the current interval. |
| Budget | The total amount of bytes that is allowed to be written in the current interval without causing an exceeded event and a failure of [XR-133](#XR133). |
| Bytes Written | How many total bytes have been written in the current interval. |
| Time Elapsed | How many milliseconds have elapsed in the current interval. |

Write stats are only tracked for writes made to the Temp Drive (T:\) or to PLS. In retail, this are the only writable local storage locations for consoles.

*Note: The first 1GB of written data is not tracked to a timed interval. This is by design and allows for a title to burst writes up-front more easily if needed. Once the first 1GB has been written, a new interval begins, and all future intervals are timed.*

**Get Storage Info Test Case**

This simple test case reports the root path of the current storage location and how many files and folders exist at the root path.

**Query Free Space Test Case**

This test uses [GetDiskFreeSpaceEx](https://docs.microsoft.com/windows/win32/api/fileapi/nf-fileapi-getdiskfreespaceexa) to calculate how much space is available at the storage location. The report will include how many bytes are available to be used, the total size of the drive, and the total amount of free bytes on the disk.

**Write File Test Case**

This test attempts to write a file to the currently selected local storage location. In most cases, this will succeed. However, it can fail in some cases:

* Attempting to write to PLS if PLS is full
  + For console only, if PLS is full but there is growable space available, a prompt to free space will be invoked.
* Attempting to write to installed game data on a package build
* Attempting to write if there is no free space available

**Read File Test Case**

This test attempts to read a file previously written with the write test above.

**Get PLS Info Test Case**

This console-only test uses *XPersistentLocalStorageGetSpaceInfo* to get information about the current PLS allocation. While this can be called on PC, space isn’t explicitly managed there. As a result, the recommendation on PC is to use [GetDiskFreeSpaceEx](https://docs.microsoft.com/windows/win32/api/fileapi/nf-fileapi-getdiskfreespaceexa).

The data returned by *XPersistentLocalStorageGetSpaceInfo* is as follows:

|  |  |
| --- | --- |
| Data | Description |
| Available Free Bytes | How many bytes is available to be written to PLS immediately. |
| Total Free Bytes | The total amount of space remaining that could be written to PLS based on the max size specified in MicrosoftGame.config. This data might have to be made available with *XPersistentLocalStoragePromptUserForSpaceAsync*. |
| Used Bytes | How many bytes are currently used in PLS. |
| Total Bytes | The total size of the PLS configuration. |

**Fill Available PLS Test Case**

This console-only test checks how much available data remains in PLS and writes data until it fills up. The rate of writing is at a constant speed equal to the max allowed by [XR-133](#XR133).

The intended usage of this test is to allow testing of growable PLS by easily filling up the available free bytes. However, the available free bytes will typically match the total free bytes making it difficult to test *XPersistentLocalStoragePromptUserForSpaceAsync*. To properly test the prompt to free space, the hard drive of the devkit should be filled up with applications or other data. Then, the available free bytes should report a value less than the total free bytes. At this point, the available data can be filled up and *XPersistentLocalStoragePromptUserForSpaceAsync* can be tested.

**Stress Write Stats Test Case**

This console-only test writes 2GB of data the currently selected local storage location. Every several seconds, the write stats are queried and reported to the on-screen log.

The purpose of this test is to show how the write stats are tracked to give a better understanding of the limitation behavior.

**XR-133: Local Storage Write Limitations**

XR-133 requires that no more than 1GB is written to the console’s hard drive over a sliding 5-minute window. This includes writes with both PLS and the Temp Storage Drive (T:\).

The two stress tests above write at a constant rate of about 3.41MB/s. However, the 5-minute window allows for bursting IO at high speeds as well so long as the total data written in the interval is managed.

In addition, the first 1GB of data written in a title’s lifetime is not tracked to a 5-minute window. Once that first 1GB has been written, all future intervals tracked with *XPackageGetWriteStats* shows the timing interval information.

# Update history

**Initial Release:** Microsoft Game Development Kit (October 2021)

# Privacy Statement

When compiling and running a sample, the file name of the sample executable will be sent to Microsoft to help track sample usage. To opt-out of this data collection, you can remove the block of code in Main.cpp labeled “Sample Usage Telemetry”.

For more information about Microsoft’s privacy policies in general, see the [Microsoft Privacy Statement](https://privacy.microsoft.com/en-us/privacystatement/).