



# Z-Wave and Z-Wave Long Range 700/800 SDK 7.19.5.0 GA Gecko SDK Suite 4.2 January 24, 2024

Z-Wave and Z-Wave Long Range 700/800 are designed to meet the demands of the future smart home, where increasing needs for more sensors and battery-operated devices require both long range and low power. Context-aware environments are the next evolution in the smart home market, and they require technologies that have been optimized specifically for these applications.

**100% Interoperable:** Every product in the Z-Wave ecosystem works with every other product, regardless of type, brand, manufacturer or version. No other smart home/IoT protocol can make this claim.

**Best-in-Class Security:** Z-Wave's Security 2 (S2) framework provides end-to-end encryption and the most advanced security for smart home devices and controllers. Homes with S2 Z-Wave devices are virtually un-hackable.

**SmartStart Easy Installation:** SmartStart radically simplifies the installation of smart devices by using QR code scans for uniform, trouble-free setup. Devices and systems can be pre-configured dramatically easing deployments.

**Backwards-Compatible:** Z-Wave certification mandates backward-compatibility. The first Z-Wave devices on the market, more than ten years old, still perform as intended in networks with the latest Z-Wave technologies.

For more information about the certification status of Z-Wave and Z-Wave Long Range 700/800 SDK v7.19.2 GA, see section [10 Product Life Cycle and Certification](#).

These release notes cover SDK version(s):

- 7.19.5.0 GA released January 24, 2024
- 7.19.4.0 GA released August 16, 2023
- 7.19.3.0 GA released May 3, 2023
- 7.19.2.0 GA released March 8, 2023
- 7.19.1.0 GA released February 1, 2023
- 7.19.0.0 Pre-Certified GA released December 14, 2022

## Compatibility and Use Notices

For more information about security updates and notices, see the Security chapter of the Gecko Platform Release notes installed with this SDK or on the [Silicon Labs Release Notes page](#). Silicon Labs also strongly recommends that you subscribe to Security Advisories for up-to-date information. For instructions, or if you are new to the Z-Wave 700/800 SDK, see section [9 Using This Release](#).



### KEY FEATURES

- Simplified application development due to 80% reduction in application code lines
- Advanced configuration for Command Classes and Z-Wave Application Framework
- Improved documentation to better support development from idea to certification
- Z-Wave Long Range Dynamic Channel selection algorithm implemented
- Z-Wave Alpha release on radio boards BRD4400B/4401B
- Simplicity Studio now has Pin Tool support for Z-Wave radio boards
- Important\_changes.md that contains all the breaking API changes introduced since last release
- LTO enabled in released software
- Tamper protection now available for Z-Wave
- S0 takes now advantage of the security features of SE
- New PC-based Controller v5.54 release
- Z-Wave Source Code available for Z-Wave Alliance members
- Improved 800 SDK demo experience independent of Simplicity Studio

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## 1 Supported Radio Boards

This section describes the radio boards supported by the certified and pre-certified applications for the 700 and 800 Series, respectively.

**Table 1-1. Supported Radio Boards.**

Series	Radio Board	Description	Applications
800	BRD4204A	EFR32ZG23: ZW-LR, SoC & 14 dBm	Serial API using BRD4002A
800	BRD4204B	EFR32ZG23: ZW-LR, SoC & 14 dBm	Serial API using BRD4002A
800	BRD4204C	EFR32ZG23: ZW-LR, SoC, 14 dBm & Secure Vault High	Serial API using BRD4002A
800	BRD4204D	EFR32ZG23: ZW-LR, SoC, 14 dBm, Secure Vault High & external 32kHz crystal mounted	Serial API using BRD4002A
800	BRD4205A	ZGM230SA: ZW-LR, SiP, 14 dBm & Secure Vault Mid	Applications using BRD4002A/BRD8029A
800	BRD4205B	ZGM230SB: ZW-LR, SiP, 14 dBm & Secure Vault High.	Applications using BRD4002A/BRD8029A
800	BRD4210A	EFR32ZG23: ZW-LR, SoC, 20 dBm & Secure Vault High	Applications using BRD4002A/BRD8029A
800	BRD2603A	ZGM230SB: ZW-LR, SiP, 14 dBm & Secure Vault Mid.	Applications using BRD2603A SDK
700	BRD4200A	ZGM130S: SiP & 14 dBm	Applications using BRD4002A/BRD8029A
700	BRD4201A	EFR32ZG14: SoC & 14 dBm	Serial API using BRD4002A
700	BRD4202A	ZGM130S: SiP, 14 dBm & no SAW filters	Applications using BRD4002A/BRD8029A
700	BRD4206A	EFR32ZG14: ZW-LR, SoC & 14 dBm	Serial API using BRD4002A
700	BRD4207A	ZGM130S: ZW-LR, SiP & 14 dBm	Applications using BRD4002A/BRD8029A
700	BRD4208A	EFR32ZG14: ZW-LR, SoC & 20 dBm	Serial API using BRD4002A
700	BRD4209A	ZGM130S: ZW-LR, SoC & 20 dBm	Applications using BRD4002A/BRD8029A

The applications in the above table need a radio board in combination with BRD4002A – Wireless Starter Kit Mainboard (WSTK) and BRD8029A – Buttons and LEDs Expansion Board. Notice that BRD4002A is compatible with the old BRD4001A mainboard that is going to be deprecated. The Serial APIs in the above table only need a radio board and a BRD4002A – Wireless Starter Kit Mainboard (WSTK). Refer to *INS14278: How to Use Certified Apps* and *INS14816: How to Use Pre-Certified Apps*, for details.

ZW-LR indicates that the radio board supports both Z-Wave and Z-Wave Long Range. 14/20 dBm indicates the transmit power of the radio board. Secure Vault is an industry-leading suite of state-of-the-art security features that address escalating Internet of Things (IoT) threats.

Please note that the radio board BRD2603A is supplied in an independent development kit called the Z-Wave 800 Series Development Kit.

Table 1-2. Radio Boards versus OPNs.

Series	Radio Board	OPN Description
800	BRD4204A	EFR32ZG23A010F512GM48
800	BRD4204B	EFR32ZG23A010F512GM48
800	BRD4204C	EFR32ZG23B010F512IM48
800	BRD4204D	EFR32ZG23B010F512IM48
800	BRD4205A	ZGM230SA27HNN0
800	BRD4205B	ZGM230SB27HGN2
800	BRD4210A	EFR32ZG23B020F512IM48
800	BRD2603A	ZGM230SB27HGN3
700	BRD4200A	ZGM130S037HGN2
700	BRD4201A	EFR32ZG14P231F256GM32
700	BRD4202A	ZGM130S037HGN2
700	BRD4206A	EFR32ZG14P231F256GM32
700	BRD4207A	ZGM130S037HGN2
700	BRD4208A	EFR32ZG14P731F256GM32
700	BRD4209A	EFR32ZG13P531F512GM48

The table above shows the Radio Boards and OPN relation. This table can be used to clarify the compatibility of the prebuilt binaries offered in the GSDK. The prebuilt binaries are built targeting boards and not OPNs. More OPNs are available than the ones listed above. For those OPNs the prebuilt binaries will not work. The desired application must be built targeting the specific OPN instead.

## 2 Z-Wave Protocol

Be aware that 800 products based on SDK v7.17.x do not support upgrade of Secure Element firmware over the air (OTA). However, a migration path exists to upgrade both main bootloader and Secure Element firmware to enable support of this feature. See *INS14895: Instruction for How to Use Tiny App* regarding the upgrade path. The 800-based SDK v7.18.x supports upgrade of Secure Element firmware over the air (OTA).

The 8 kB reduction of the Z-Wave protocol NVM3 file system has an impact when making OTA firmware update on 800-based applications deployed on version 7.17.2 and earlier. To make an OTA firmware update from 7.17.2 to 7.18.1/2 requires that 7.18.1/2 is modified to keep the same NVM3 protocol size as 7.17.2. This can be configured by the define `NVM3_DEFAULT_NVM_SIZE` when building 7.18.1/2.

The 800 series based end device will hang in a boot loop if security keys are manually written in Manufacturer Tokens.

Note that due to the introduction of Secure Key Storage on the 800 series, having externally supplied key pairs is no longer supported. To ensure that security is not compromised, keys are generated internally on first boot and kept only in secure storage. The public key and the QR code can be read out in production.

### 2.1 New Items

None

### 2.2 Improvements

None

## 2.3 Fixed Issues

### Fixed in release 7.19.5 GA

ID #	Description
1183767	A device stays awake when receiving a nonce synchronization.
1166462	Reset when the controller's state machine is in unexpected states.

### Fixed in release 7.19.4 GA

ID #	Description
1126896	Fixed an issue triggering a device to send multiple corrupted packets over the air. The issue could result in extended communication issues.

### Fixed in release 7.19.2 GA

ID #	Description
1088495	Not possible to migrate NVM3 files from a 700 based system to a 800 system. Especially important for gateways when replacing a 700 with a 800.
1059617	The Zniiffer PTI doesn't contain Home ID Hash for Wake Up Beams.

### Fixed in release 7.19.0 Pre-Certified GA

ID #	Description
1018947	SerialAPI: SERIAL_API_SETUP_CMD_MAX_LR_TX_PWR_GET does not reflect actual tx power if the power is set to an illegal value.
1063249	Inclusion can occasionally fail when a lot of FLiRS devices are present in the network. In networks with 20+ FLiRS nodes it is recommended to set the ADD_NODE_OPTION_NO_FL_SEARCH when starting add mode on a controller. When inclusion is completed successfully a call to FUNC_ID_ZW_REQUEST_NODE_NEIGHBOR_UPDATE should be made to ensure that the routing table is updated correctly for the newly included node.
1062862	SAW filter pins are not set correctly in SerialAPI.
1061965	Singlecast frame is not sent after failed beaming attempt on LR.
1027062	Enabled watchdog could in rare cases reset a controller during a route calculation in case it takes more than 2 seconds.
1040308	End nodes could unintentionally reset during power power down if the power down process is interrupted by network traffic.
1028809	Wrong setting of LETIM0 OUT0 location for LED2 and LED3 in extension_board_8029a_efr32zg23.h (800 series).
1026711	After OTA the RTCC retention registers are erased.
1018947	SERIAL_API_SETUP_CMD_MAX_LR_TX_PWR_GET does not reflect actual Tx power.
1015803	Unable to set max Tx power in ZWLR.
752879	Enabling LTO triggered bugs.



## 2.4 Known Issues in the Current Release

Issues in bold were added since the previous release. If you have missed a release, recent release notes are available on [Silicon Labs Release Notes page](#)

ID #	Description	Workaround
753756	Network Wide Inclusion (NWI) of 500-based apps doesn't work through 700/800 repeaters.	NWI works at second attempt.
355095	In small networks Assign Return Routes will only generate direct range or one-hop routes even though multi-hop routes are possible.	None
361273	Transport Service is used when it is necessary to split a frame in two parts due to size. However, Transport Service does not forward RSSI information from the lower layers but only routing information. The RSSI value is the difference between LWR RSSI and background RSSI. As a consequence it is not possible to use RSSI for large frames handled by Transport Service in a network health calculation.	None
824067	Sensor unable to sync S2 and in loop sending S2 Nonce Get frames.	None

## 2.5 Deprecated Items

None

## 2.6 Removed Items

None

## 3 Z-Wave Plus V2 Application Framework

### 3.1 New Items

None

### 3.2 Improvements

For a detailed description of application development using the Z-Wave Plus V2 Framework, refer to *INS14259: Z-Wave Plus V2 Application Framework SDK7*.

A porting guide is also available for customers who want to migrate 800 hardware. The guide contains a detailed example of how to port a non-component/700-based Switch On/Off App (7.16.3) to a component/800-based Switch On/Off App (7.17.0). See *APL14836: Application Note for Porting Z-Wave Appl. SW from 700 to 800 hardware*.

More mandatory logic was moved from the application to ZAF. This contributed to bringing down the total number of lines in the application. This should decrease time to market for new products.

### 3.3 Fixed Issues

#### Fixed in release 10.19.2 GA

ID #	Description
1105481	The Supervision Command Class doesn't handle the Supervision Report command's "more status update" bit correctly on those applications that use more Supervision Reports sending to report ongoing Request job. Impacted example application is the <code>zwave_soc_door_lock_keypad</code> . The application sends the report when door lock operation is started, but the report for finishing the operation is missing.
1103068	After OTA firmware update, every SW reset triggers a Firmware Update Md Status Report frame being sent. This should be done only once after applying the image.

#### Fixed in release 10.19.1 GA

ID #	Description
1088994 1058487	Erronous generation of Configuration Properties Report for 1, 2 and 4 bytes.
1088496	Erronous determination of max. length of info field in the Configuration Info Report causing incorrectly reported info if it could not fit into a single frame.
1079311	Multiple Configuration Bulk Reports are now generated correctly.

#### Fixed in release 10.19.0 Pre-Certified GA

ID #	Description
1062840	Configuration Command Class handler issue.
1055556	When receiving association set frame the nodes are caught and, if the number of nodes exceeds the maximum storage limit, flushing is aborted.
1039730	S2 sequence number does not retain count during OTA.
820843	Project cannot build after installing command class component.

### 3.4 Known Issues in the Current Release

Issues in bold were added since the previous release. If you have missed a release, recent release notes are available on the [Silicon Labs Release Notes page](#)

ID #	Description	Workaround
369430	All S2 multicast frames are sent using verified delivery S2_TXOPTION_VERIFY_DELIVERY whether or not a response is expected.	Change source code depending on the frame sent.
1086946	The Z-Wave ZAF Component does not display the default setting for Icon Type and Device Type.	Currently not available.
1062482	OTA firmware update gets stuck when a Timer interrupt is triggered to toggle a GPIO frequently.	Currently not available.
1080416	The ASSERT macro does not print the file and line when it is used in the ApplicationTask function.	Prints after disabling all interrupts.

### 3.5 Deprecated Items

None

### 3.6 Removed Items

None

## 4 Certified Applications

The certified applications based on v7.x.1+ will be formally certified by a certification house. However, the first release (v7.x.0) will only contain pre-certified applications based on a certification test using CTT v3. Refer to *INS14278: How to Use Certified Apps* for details.

### 4.1 Door Lock Key Pad

#### 4.1.1 New Items

None

#### 4.1.2 Improvements

None

#### 4.1.3 Fixed Issues

None

#### 4.1.4 Known Issues in the Current Release

None

#### 4.1.5 Deprecated Items

None

#### 4.1.6 Removed Items

None

### 4.2 LED Bulb

#### 4.2.1 New Items

None

#### 4.2.2 Improvements

None

#### 4.2.3 Fixed Issues

None

#### 4.2.4 Known Issues in the Current Release

None

#### 4.2.5 Deprecated Items

None

#### **4.2.6 Removed Items**

None

### **4.3 Power Strip**

#### **4.3.1 New Items**

None

#### **4.3.2 Improvements**

None

#### **4.3.3 Fixed Issues**

None

#### **4.3.4 Known Issues in the Current Release**

None

#### **4.3.5 Deprecated Items**

None

#### **4.3.6 Removed Items**

None

### **4.4 Sensor PIR**

#### **4.4.1 New Items**

None

#### **4.4.2 Improvements**

None

### 4.4.3 Fixed Issues

#### Fixed in release 10.19.1 GA

ID #	Description
758906	Wakeup current had increased on both 700 and 800 SoCs. This was caused by an unintentional IR calibration performed at start-up.

### 4.4.4 Known Issues in the Current Release

Issues in bold were added since the previous release. If you have missed a release, recent release notes are available on the [Silicon Labs Release Notes page](#)

ID #	Description	Workaround
1065157	Multilevel Sensor can't send Multilevel Sensor Report based on auto report timer.	Currently not available.

### 4.4.5 Deprecated Items

None

### 4.4.6 Removed Items

None

## 4.5 Switch On/Off

### 4.5.1 New Items

None

### 4.5.2 Improvements

None

### 4.5.3 Fixed Issues

None

### 4.5.4 Known Issues in the Current Release

None

### 4.5.5 Deprecated Items

None

### 4.5.6 Removed Items

None

## 4.6 Wall Controller

### 4.6.1 New Items

None

### 4.6.2 Improvements

None

### 4.6.3 Fixed Issues

#### Fixed in release 10.19.2 GA

ID #	Description
1098671	WallController project build fails in Simplicity Studio.

### 4.6.4 Known Issues in the Current Release

None

### 4.6.5 Deprecated Items

None

### 4.6.6 Removed Items

None

## 5 Pre-Certified Applications

The pre-certified applications will not be formally certified but certification tests have been performed based on CTT v3. Refer to *INS14816: How to Use Pre-Certified Apps* for details.

### 5.1 Multilevel Sensor

#### 5.1.1 New Items

None

#### 5.1.2 Improvements

None

#### 5.1.3 Fixed Issues

None

#### 5.1.4 Known Issues in the Current Release

None

#### 5.1.5 Deprecated Items

None

#### 5.1.6 Removed Items

None

### 5.2 Key Fob Controller

This application is new as of 7.18.x. It offers an example of how to create a key fob that is able to include and control other Z-Wave nodes. One use case could be a kit consisting of a key fob and a battery-driven shade. As the key fob can add more devices to its network, it opens the possibility for adding additional shades.

#### 5.2.1 New Items

None

#### 5.2.2 Improvements

None

#### 5.2.3 Fixed Issues

None

#### 5.2.4 Known Issues in the Current Release

None



### 5.2.5 Deprecated Items

None

### 5.2.6 Removed Items

None

## 6 Serial API Applications

Beginning with version 7.16, when backing up and restoring a SerialAPI via the FUNC\_ID\_NVM\_BACKUP\_RESTORE, the SerialAPI will automatically upgrade the protocol non-volatile memory (NVM) to the latest version. Any backup made of a 7.16 or later SerialAPI can be restored to its original version or to a later version of the SerialAPI without any manual upgrade of the protocol NVM being necessary.

The serial interface is unchanged in version 8.

As of SDK version 7.18.x, Serial API is available as source code as well as binary. This opens the possibility for building customized versions of Serial API with different pin configuration or additional hardware utilization. A use case might be to use SPI instead of UART for serial communication.

No application using Serial API End Device is available in the GSDK.

### 6.1 Serial API Controller

#### 6.1.1 New Items

None

#### 6.1.2 Improvements

None

#### 6.1.3 Fixed Issues

##### Fixed in release 10.19.1 GA

ID #	Description
743042	SERIAL_API_SETUP_CMD_SUPPORTED was missing in the supported sub commands flag and the bits for setup supported sub commands bitmask were not shifted back.

#### 6.1.4 Known Issues in the Current Release

None

#### 6.1.5 Deprecated Items

None

#### 6.1.6 Removed Items

None

## 7 Important Changes

Starting in version 7.19, API-breaking changes have been documented in the document "Important\_changes.md" available in GSDK. Please check it for a detailed description of changes introduced in the latest release.

HTML documentation has been added to GSDK and can be found in Simplicity Studio, Documentation section, under "Z-Wave zipped doxygen documentation". Location of this document is <SDK>/protocol/z-wave/studio-docs/z-wave-html-docs.zip.

## 8 Open Source Software

Z-Wave is using FreeRTOS as the underlying OS, and it is based on FreeRTOS Kernel V10.4.3.

## 9 Using This Release

This release contains the following

- Z-Wave Plus V2 Application Framework
- Z-Wave Certified Applications for a broad range of smart home applications
- Z-Wave Protocol and Serial API Applications

If you are a first-time user, Z-Wave documentation is installed with the SDK. See [INS14280: Z-Wave Getting Started for End Devices](#), [INS14278: How to Use Certified Apps in Z-Wave](#), and [INS14281: Z-Wave Getting Started for Controller Devices](#) for instructions.

This SDK depends on a Gecko Platform. The Gecko Platform code provides functionality that supports protocol plugins and APIs in the form of drivers and other lower layer features that interact directly with Silicon Labs chips and modules. Gecko Platform components include EMLIB, EMDRV, RAIL Library, NVM3, PSA, and mbedTLS. Gecko Platform release notes are available through Simplicity Studio's Launcher Perspective.

### 9.1 Installation and Use

Order a Z-Wave Wireless Starter kit. The kit offers the easiest and fastest way to start evaluation and development of your own Z-Wave mesh application. It provides a single world-wide development kit for both end devices and gateways with multiple radio boards, with which developers can create a mesh network and evaluate the Z-Wave module.

The Z-Wave and Z-Wave Long Range 700/800 SDK is provided as part of the Gecko SDK (GSDK), the suite of Silicon Labs SDKs. To quickly get started with the GSDK, install [Simplicity Studio 5](#), which will set up your development environment and walk you through GSDK installation. Simplicity Studio 5 includes everything needed for IoT product development with Silicon Labs devices, including a resource and project launcher, software configuration tools, full IDE with GNU toolchain, and analysis tools. Installation instructions are provided in the online [Simplicity Studio 5 User's Guide](#).

Alternatively, Gecko SDK may be installed manually by downloading or cloning the latest from GitHub. See [https://github.com/SiliconLabs/gecko\\_sdk](https://github.com/SiliconLabs/gecko_sdk) for more information.

Simplicity Studio installs the GSDK by default in:

- (Windows): C:\Users\<<NAME>\SimplicityStudio\SDKs\gecko\_sdk
- (MacOS): /Users/<NAME>/SimplicityStudio/SDKs/gecko\_sdk

To implement a specific application, Silicon Labs recommends starting with one of the existing pre-certified apps with the desired Role Type.

### 9.2 Security Information

#### Secure Vault Integration

This version of the stack are using secure vault interface for key management of asymmetric keys (ECC Curve 25519) and Symmetric keys (AES).

#### Security Advisories

To subscribe to Security Advisories, log in to the Silicon Labs customer portal, then select **Account Home**. Click **HOME** to go to the portal home page and then click the **Manage Notifications** tile. Make sure that 'Software/Security Advisory Notices & Product Change Notices (PCNs)' is checked, and that you are subscribed at minimum for your platform and protocol. Click **Save** to save any changes.

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<input type="checkbox"/> Clocks	<input type="checkbox"/> Wi-Fi
<input type="checkbox"/> Buffers	<input type="checkbox"/> ZigBee and Thread
<input type="checkbox"/> Oscillators	<input type="checkbox"/> Z-Wave
<input type="checkbox"/> CDR and PHY	

## 9.3 Support

Development Kit customers are eligible for training and technical support.

See support resources and contact Silicon Laboratories support at <http://www.silabs.com/support>.

## 10 Product Life Cycle and Certification

Silicon Labs will add new features based on market requirements and continuously improve the Z-Wave Protocol to position the Z-Wave Ecosystem. The Z-Wave Protocol Life Cycle is a process to provide rapid innovation, new features and robust matured protocol release to Z-Wave Partners. The Z-Wave Protocol Life Cycle defines the maturation process of Z-Wave Protocol generations and consist of three phases divided in five Life Cycle stages. A change in the Z-Wave SDK utilized for a specific device does require recertification; however, the type of certification required, the amount of testing needed, and the associated fees depend on the scope of the change. Refer to Z-Wave Alliance home page <https://z-wavealliance.org/> for details.

**Table 10-1. Z-Wave SDK Release History**

Series	SDK Version	Release Date [DD-MMM-YYYY]
700/800	7.20.1 GA	26-JUL-2023
700/800	7.20.0 Pre-Certified GA	07-JUN-2023
700/800	7.19.4 GA	16-AUG-2023
700/800	7.19.3 GA	03-MAY-2023
700/800	7.19.2 GA	08-MAR-2023
700/800	7.19.1 GA	01-FEB-2023
700/800	7.19.0 Pre-Certified GA	14-DEC-2022
700/800	7.18.4 GA	18-JAN-2023
700/800	7.18.3 GA	19-OCT-2022
700/800	7.18.2 GA	28-SEP-2022
700/800	7.18.1 GA	17-AUG-2022
700/800	7.18.0 Pre-Certified GA	08-JUN-2022
700/800	7.17.2 GA	09-MAR-2022
700/800	7.17.1 Pre-Certified GA	28-JAN-2022
700/800	7.17.0 Pre-Certified GA	08-DEC-2021
700	7.16.3 GA	13-OCT-2021
700	7.16.2 GA	08-SEP-2021
700	7.16.1 GA	21-JUL-2021
700	7.16.0 Pre-Certified GA	16-JUN-2021
700	7.15.4 GA	07-APR-2021
700	7.15.2 Pre-Certified GA	27-JAN-2021
700	7.15.1 Pre-Certified GA	09-DEC-2020
700	7.14.3 GA	14-OCT-2020
700	7.14.2 GA	09-SEP2020
700	7.14.1 GA	29-JUL-2020
700	7.14.0 Beta	24-JUN-2020
700	7.13.11 GA	02-NOV-2022
700	7.13.10 GA	18-AUG-2021
700	7.13.9 GA	03-MAR-2021
700	7.12.2 GA	26-NOV-2019

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700	7.12.1 GA	20-SEP-2019
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