MSI Afterburner v4.6.4

MSI Afterburner is ultimate graphics card utility, co-developed by MSI and RivaTuner teams. Please visit https://msi.com/page/afterburner to get more information about the product and download new versions

System requirements:

- Windows XP, Windows Vista, Windows 7, Windows 8, Windows 8.1 or Windows 10 (both x86 and x64 versions) with full administrative rights
- NVIDIA GeForce 6 or newer series graphics card with NVIDIA ForceWare 96.xx or higher drivers [1]
- AMD RADEON HD 2000 or newer series graphics card with AMD Catalyst 9.3 or higher drivers [2]
- Any graphics card can be used to start application in limited functionality mode[3]

Features:

- Based on RivaTuner core, Afterburner contains the mix of the most popular and frequently used RivaTuner's technologies exposed in new simple and effective user interface
- Unified features for both AMD and NVIDIA graphics cards. You no longer need to change your favorite graphics card utility software when migrating from NVIDIA graphics card to AMD and vice versa. Afterburner provides you almost the same functionality for hardware manufactured by both leading GPU vendors and makes migration process really easy. Just keep overclocking and monitoring your GPU like you are used to do, no need to change your preferences and search for other utility after graphics card upgrade!
- User extendable architecture. You may express your creativity and design your own skins for MSI Afterburner, develop monitoring plugins or external applications interacting with MSI Afterburner (e.g. sidebar gadgets or smartphone applications remotely controlling your hardware), create localization for your native language and many, many more!
- Basic overclocking and fan control features including full multi-GPU support, independent shader clock adjustment (NVIDIA GeForce 8, 9 and 200 series cards[4]), overclocking and fan control profiles with hotkey based activation abilities
- Power limit control via AMD PowerTune and NVIDIA GPU Boost technologies
- Desktop and in-game screen capture features support. BMP, PNG and JPG formats are supported[5]
- Realtime desktop and in-game video capture support via Predator™ technology[6]. Uncompressed, high-performance custom RTV1 and native MJPG video encoding, encoding with third-party external VFW compatible codecs (e.g. Lagarith or x264vfw) and hardware accelerated encoding via Intel QuickSync, NVIDIA NVENC and AMD VCE are supported in conjunction with wide range of additional video capture related options, multisource stereo and multichannel (for Window Vista and newer) audio capture with Push-To-Talk support. The functionality of expensive commercial video capture products is now available to everyone absolutely for free! There is no need to buy dedicated video capture software anymore!
- Advanced fan control. Most of fan control tools allow you to use either fixed manual fan speed mode or default automatic fan speed mode, where the fan speed automation is performed either by dedicated hardware chip or by display driver depending on graphics card model. In addition to these traditional fan control modes Afterburner also provides user defined software automatic fan speed mode allowing you to define your own fan speed curve. New mode combines flexibility of RivaTuner's fan speed scheduling technology with new and really easy to use graphical interface for visual fan speed curve editing
- Hardware health monitoring features including popular tray icon, Logitech LCD and On-Screen Display[7] monitoring modes and history logging in native RivaTuner hardware monitoring log file format
- Automatic profiles management system allows experienced users to define their own dynamic downclocking rules on the systems with no hardware downclocking support or program different fan control modes for 2D and 3D applications[8]
- Core [9], auxiliary VDDCI/PEXVDD/1V8 and memory [10] voltage control gives more freedom to hardcore overclockers. Please refer to your retail MSI graphics card box to find MSI Afterburner voltage control compatibility logos

[1] Integrated and mobile graphics cards are not officially supported
[2] Integrated and mobile graphics cards are not officially supported
[3] Limited functionality mode restricts overclocking, hardware control and monitoring features, but allows you to use hardware independent features like high-performance Predator™ video capture module
[4] Independent shader clock control is outdated technology, which is supported via special legacy UI skin only
[5] Additional RivaTuner Statistics Server application installation is required for this functionality
[6] Additional RivaTuner Statistics Server application installation is required for this functionality
[7] Additional RivaTuner Statistics Server application installation is required for this functionality
[8] Additional RivaTuner Statistics Server application installation is required for this functionality
[9] Reference design PCB and original reference VGA BIOS are required for proper core voltage control on the majority of reference design graphics cards. Core voltage control may function improperly when voltage control circuit on the PCB or voltage table in VGA BIOS are modified by graphics card vendor or by end user
[10] Auxiliary and memory voltage control is supported only on some custom design MSI graphics card models

Known limitations:

- Additional RivaTuner Statistics Server process is required to provide some functionality including framerate monitoring, On-Screen Display, screen capture, video capture and automatic profiles management. The server will be automatically launched by MSI Afterburner as soon as you enable any of the features listed above. You will not be able to shut down the server manually while these features are in use, that is by design of MSI Afterburner
- Framerate monitoring, On-Screen Display, screen capture, video capture and automatic profiles management functionality can be incompatible with some third-party On-Screen Display software (e.g. XFire or Steam In-Game Chat). The limitation is not specific to our product, many third-party products are designed to be the only On-Screen Display products in the system and to block their own functionality when any other On-Screen Display software is running
- Anticheat systems of some online games may restrict On-Screen Display usage and block connection to the server when RivaTuner Statistics Server is running

Revision history:

Version 4.6.4

- Added voltage control for reference design AMD RADEON RX 6700 XT series graphics cards
- Added experimental support for Intel 11th generation CPUs
- Added experimental support for mobile AMD Ryzen CPUs
- Fixed issue with missing memory temperature sensor on AMD RADEON 5700 / 5700 XT series graphics cards
- Increased memory overclocking limit for NVIDIA GeForce RTX 30x0 series graphics cards
- RivaTuner Statistics Server has been upgraded to v7.3.2

Version 4.6.3 (published on 03.03.2021)

- Added NVIDIA Ampere GPU architecture support:
    - Added new fan control 3.0 API support
    - Added new integrated OC Scanner API support, please read below to get more information about new OC Scanner implementation
- Added AMD Navi 21 GPU architecture support
- Updated bundled MSI Overclocking Scanner application:
    - Starting from 455.xx drivers family, NVIDIA OS Scanner is no longer implemented as a separate software component redistributed with each AIC partner's overclocking software. Now NVIDIA OC Scanner is integrated into the driver and third party software can natively access it via NVAPI. Such implementation simplifies the process of OC Scanner maintenance for NVIDIA, it is no longer necessary to ship updated software components to AIC partners and re-release each partners' software when something needs to be changed inside OC Scanner from NVIDIA side. MSI Overclocking Scanner supports both implementations of NVIDIA OC Scanner API:
        - Old legacy implementation of NVIDIA OC Scanner via separate software components for NVIDIA Pascal and Turing architectures for pre-455.xx drivers family
        - New integrated NVAPI based implementation of NVIDIA OC Scanner for 455.xx and newer NVIDIA display drivers
    - New NVAPI based OC scanner implementation features the following changes and improvements:
        - Automated overlocking support for both core and memory clocks
        - OC Scanners's results are now persistent. It means that once the scanning process succeeds, NVIDIA driver internally saves optimized voltage/frequency curve and overclocked memory clock and apply them as new system defaults after reboot, even if you close or uninstall overclocking application. Now there is new *"Revert"* button inside MSI Overclocking Scanner, which allows you to revert overclocked curve and memory clocks to their real defaults
        - Manually adjusted clock/frequency curve stability testing functionality is deprecated and no longer available
- Added voltage control for reference design NVIDIA GeForce RTX 30x0 series graphic cards
- Added voltage control for reference design AMD RADEON RX 6800 / 6900 XT series graphics cards
- Added new MSI Ampere, MSI Big Navi, MSI Indigo and MSI Cyborg v2 skins by Drerex design
- Added experimental support for Intel 10th generation CPUs
- Added experimental support for AMD Zen3 CPUs
- Altered synchronization mutex name for AMD SNM registers access in AMD Ryzen temperature monitoring implementation
- Fixed abnormally high PCIE bus usage value monitored on NVIDIA GPUs after display driver crash and recovery or on Optimus platforms when discrete GPU is sleeping
- Fixed issue with monitoring window displayed in minimized state on the first detach with some skins
- Improved automatic software fan control implementation:
    - Added new hybrid automatic software fan control mode. This mode allows you to combine default hardware fan curve and user defined software fan curve and dynamically switch between those two modes on temperature threshold. Such implementation can be useful on the cards with limited software fan control range (on both AMD and NVIDIA hardware) if you wish to use deault hardware fan curve (with active native fan stop technology) in lower temperatre range and use customized software fan curve in higher temperature zone. This is achieved by new *"Override zero fan speed with hardware curve"* option. When this option is enabled, you're telling MSI Afterburner to engage default fan control mode in zero fan speed zone of your custom fan curve
    - Added new *"Use firmware control mode"* option to software automatic fan control module. This option allows customizing fan curve at GPU firmware level instead of doing it entirely in software, so it doesn't require keeping MSI

Afterburner loaded in memory in order to get custom fan curve working. Also this option can be used to bypass various third party issues related to broken fixed fan speed programming API in some display drivers (e.g. Overdrive8 API related screen flickering on some AMD GPUs). New option is only supported on limited set of modern GPUs (Vega and newer AMD GPU families, Ampere and newer NVIDIA GPU families) and it has multipe GPU firmware based limitations such as limited maximum supported number of nodes for the curve (quad slope curve and up to 5 curve nodes on AMD, dual slope curve and up to 3 curve nodes on NVIDIA), lack of step/linear mode switching support, lack of hysteresis adjustment support etc. Please refer to new option context help to get more details

- Improved hardware monitoring module:
  - Added native NVAPI based implementation of absolute GPU power monitoring for NVIDIA GPUs
  - Improved GPU.dll plugin. Open source code of updated plugin demonstrates implementation of new data sources: *"GPU dedicated memory \ process"* and *"GPU shared memory \ process"*. Performance counters represented by new data sources are displaying local and non-local VRAM commits for foreground process, so you may use them to see how much VRAM is allocated by the game you're currently playing and compare it with total system-wide VRAM usage reflected by *"Memory usage"* data source. Implementation of new data sources is based on low-level D3DKMT API, which is allowing a process to peek into other process specific D3D performance counters. Due to such implementation model new *"GPU dedicated memory \ process"* and *"GPU shared memory \ process"* are not supported for EAC/BattleEye protected titles
  - Added internal *"Memory usage \ process"* and *"RAM usage \ process"* graphs based on asynchronous process performance counter access interface introduced by RivaTuner Statistics Server v7.3.0. Implementation is similar to new data sources introduced by updated GPU.dll plugin, but unlike the plugin, internal sources are being asynchronously polled by digitally signed RivaTuner Statistics Server's hook modules in context of the game process, so they support in-process VRAM and RAM reporting for EAC/BattlEye protected and UWP titles. It is strongly recommended to use those internal data sources instead of their clones located in GPU.dll. GPU.dll implementation is mainly intended to be open source tutorial for third party monitoring applications developers
- Added workaround for AMD driver bug causing short display flicker during applying new fan settings on some multi-monitor or single monitor high refresh rate display configurations
- *"Erase autosaved startup settings"* option is now disabled by default in AMD compatibility properties
- Now MSI Afterburner is forcibly disabling Zero RPM when applying new fixed fan speed in order to bypass AMD driver bug preventing fan control from working when Zero RPM mode is enabled on some systems. If Zero RPM is working properly on your system and you still want to keep it enabled when adjusting fan speed, you may disable forcible Zero RPM override with power oriented switch in application configuration file
- Now MSI Afterburner is displaying the minimum allowed fan speed in software fan curve editor window on Overdrive 8 capable AMD GPUs. The latest AMD drivers will not allow you to set fan speed below this limit, that's by design of driver
- AMD ADL components are loaded by absolute path now to prevent possible DLL hijacking
- Unlocked old alternate clock monitoring functionality from original RivaTuner era. Power users may switch to PLL clock monitoring mode instead of default target clock monitoring mode on NVIDIA GPUs
- Tightened IO driver access policy, the driver can no longer be accessed by users with no administrative rights
- RivaTuner Statistics Server has been upgraded to v7.3.0. This version introduces plugins architecture and brand new visual overlay editor plugin, we strongly recommend you to try it if you're advanced user and want to customize your OSD beyond the possibilities of MSI Afterburner's internal OSD layout editor

Version 4.6.2 (published on 29.10.2019)

- Added voltage control for reference design NVIDIA GeForce RTX 20x0 SUPER series graphic cards
- Added voltage control for reference design NVIDIA GeForce GTX 1660 SUPER series graphic cards
- Added voltage control for AMD RADEON RX 5700 series graphics cards
- Added new MSI Steampunked, MSI Lightning Anniversary and MSI Mystic skins by Drerex design
- Improved hardware monitoring module:
  - Added CPU temperature monitoring support for AMD Ryzen 3X00 processors family
  - Added thermal offset for CPU temperature monitoring on AMD Ryzen Threadripper 29X0 processors family
  - Added package CPU power and per-core CPU power monitoring for AMD Ryzen processors family
  - Improved monitoring plugins architecture:
    - Added API function for reading host application's hardware monitoring timestamp from the plugins. The timestamp is updated by host on each hardware polling iteration, so it allows the plugin to precache and reuse some sensor data if the same physical sensor value is being used in multiple data sources exported by plugin. Such approach is demonstrated in updated CPU.dll plugin for duplicating the same temperature sensor value for all cores on AMD CPUs
    - Added optional plugin unititialization callback function, which is called by the host before unloading the plugins. New multithreaded Ping.dll plugin is demonstrating new function usage to shut down ping monitoring thread properly
  - Improved monitoring plugins:

        - Updated CPU.dll plugin is demonstating AMD Ryzen CPU temperature monitoring implementation and optimal duplication of the same temperature sensor readback for all CPU cores
        - Added new Ping.dll plugin for monitoring ping to desired server via ICMP echo requests. Please take a note that the plugin is configured to monitor ping to www.guru3d.com by default, it is up to you to specify target server name or IP address in the plugin properties
- Improved skin engine:
    - Optimized skin rendering performance for skins using multiple overlapped animated indicators
    - Added position smoothing support to skinned indicators
    - Now skinned applications can forcibly disable indicator animation if necessary
    - Skin format reference guide has been updated to v1.8 to document these changes
- Updated IO driver provides more secure MMIO and MSR access interface
- RivaTuner Statistics Server has been upgraded to v7.2.3

Version 4.6.1 (published on 21.04.2019)

- Added new MSI Touch of Modern skin by Drerex design
- Added asynchronous dual fan control support for reference design NVIDIA GeForce RTX 20x0 series graphics cards. Please take a note that only 100% NVIDIA reference design dual fan control implementations are supported, third party proprietary asynchronous fan control solutions (e.g. EVGA iCX series asynchronous fans) are not supported and will not be supported in future versions. The following asynchronous fan control functionality is available:
    - Added new *"Synchronize fan speeds"* button, which is allowing you to switch between synchronous and asynchronours fan control modes. Please take a note that new fan speed controls are available in v4 skins only, v3 and v2 skins are deprecated and no longer receive new functionality
    - When fan speeds synchronization is enabled, MSI Afterburner's fan control functionality behaves exactly like in the previous version, i.e. both fans are running asynchronically in default hardware automatic fan speed control mode but become linked synchronically if you enable manual or software automatic fan speed control mode
    - When fan speeds synchronization is disabled, you may select and adjust each fan speed independently. For software automatic fan speed control mode independent temperature curves are also adjustable for each fan
- Improved hardware monitoring module:
    - Inverted hotkeys handling approach for multiple selected hardware monitoring graphs. Previously single graph settings mode was active by default, but you could apply some settings (e.g. *"Show in On-Screen Display"*) to multiple selected graphs with *<Ctrl>* hotkey modifier. Now such settings are applied to multiple selected graphs by default and *<Ctrl>* hotkey modifier is used to apply settings to single focused graph
    - Group operation notifier has been moved to hardware monitoring graph properties header
    - Improved backward compatibility with monitoring profiles created in the previous versions of application. It is no longer necessary to recreate the profiles having monitoring settings without On-Screen Display layout
    - It is no longer necessary to click <Apply> button inside the On-Screen Display layout editor after changing current layout, now the changes are applied properly on closing the editor
    - The progress of saving multiple graphs' settings is now displayed in the caption of the application's property sheet
    - Optimized handling of "dirty" flag for settings decreases saving time for multiple graph's settings when using multiple subsequent group operations
    - Added new *"Hide attached monitoring panel"* command to the context menu of hardware monitoring window. You may use it to toggle visibility of monitoring window when it is attached to the main application window
    - Now you may press *<Ctrl> + <M>* hotkeys to toggle monitoring window attachment
- Improved voltage/frequency curve editor for both AMD and NVIDIA GPUs:
    - Now you may hold *<Shift>* and press left mouse button on initial desired horizontal position in the editor window to begin fragment selection, then drag mouse cursor to desired final horizontal position and release left mouse button to select a fragment. The following functionality is available for selected fragments:
        - You may double click the editor window to reset fragment selection
        - You may adjust the offset for any point inside the selection with mouse cursor to apply the same offset simultaneously to all selected points
        - You may adjust the offset for any point inside the selection with keyboard cursor keys, *<Enter>* or *<Shift>+<Enter>* keys to apply the same offset or specify the same target frequency or voltage for all selected points
- Improved skin engine:
    - Skin engine no longer crashes when switching between the skins having the same site with and without alpha channel
    - Added thumbless skinned slider controls support
    - Added alpha path threshold support for skinned slider controls
- Improved skin cross-compatibility layer:
    - Extended list of applications supported by skin cross-compatibility layer

    - Various compatibility fixes for third party skins supported by cross-compatibility layer
- Fixed issue with GUI stopping responding during adjusting skin scaling ratio on the fly in high DPI mode when skin composition mode was set to layered mode with alpha
- Updated third party hardware database:
    - Added new third party voltage control capable graphics cards to the database
    - Added new third party graphics cards with multichannel GPU, memory and VRM temperature sensors to the database
- RivaTuner Statistics Server has been upgraded to v7.2.2

Version 4.6.0 (published on 09.03.2019)

- Added NVIDIA Turing GPU architecture support:
    - Added voltage control for reference design NVIDIA GeForce RTX 20x0 series graphics cards
    - Advanced GPU Boost control for NVIDIA GeForce RTX 20x0 series graphics cards. Extended voltage/frequency curve editor on GeForce RTX 20x0 family graphics cards allows you to tune additional piecewise power/frequency floor and temperature/frequency floor curves. Control points on those new curves allow you to control GPU Boost power and thermal throttling algorithms more precisely than traditional power limit and thermal limit sliders
    - Hardware abstraction layer has been revamped to provide support for multiple independent fans per GPU due to introducing dual fan design on reference design NVIDIA GeForce RTX 20x0 series graphics cards and due to introducing native dual fan control in NVAPI. Both fans of NVIDIA GeForce RTX 20x0 can be monitored independently in hardware monitoring module now and can be controlled synchronically in manual mode
    - Added NVIDIA Scanner technology support
- Added Monolithic Power Systems MP2884A and MP2888A voltage controllers support
- Added core, memory, auxiliary PEXVDD and auxiliary 1V8 voltage control for custom design MSI RTX 2080Ti Lightning series graphics cards with MP2888A + MP2884A +uP1816 voltage regulators
- Added VRM and VRM2 temperature monitoring for custom design MSI RTX 2080Ti Lightning series graphics cards
- Added AMD Vega 20 GPU architecture support:
    - Added Overdrive 8 technology support for AMD RADEON VII series graphics cards
    - Added extended thermal monitoring for RADEON VII series graphics cards. Extended thermal monitoring includes dual-channel GPU temperature monitoring (edge and junction temperatures), memory temperature monitoring and quad-channel VRM temperature monitoring (core, SOC and two memory VRM temperatures)
    - GPU usage monitoring filtering algorithms are reenabled for AMD ADL based GPU usage monitoring implementation to minimize fluctuations in monitored GPU usage on AMD RADEON VII series graphics cards. Please take a note that filtering algorithms make GPU usage graph more inert and smooth, so you may disable them via configuration file if necessary
- Added fan control support for AMD Adrenalin 2019 drivers family. Please take a note that AMD Adrenalin 2019 drivers adjust fan speed in PWM duty cycle mode but fan speed monitoring is provided in RPM only, which means that you cannot read back exact programmed fan speed in percents. Due to this limitation, MSI Afterburner is reporting fan speed as percent of maximum RPM instead of real fan duty cycle when default AMD auto fan control is in use. So monitored fan speed can slightly mismatch programmed fan speed curve if you're using default AMD automatic fan control
- Added new MSI Gaming Z skin by Drerex Design
- Improved hardware monitoring module:
    - Added thermal offset for CPU temperature monitoring on AMD Ryzen 7 2700X processors
    - Similar CPU temperatures are now cloned for all cores on AMD CPUs to provide more convenient and unified On-Screen Display layout between Intel and AMD CPUs
    - *"Pagefile usage"* graph in hardware monitoring module has been renamed to *"Commit charge"*
    - Added group operation notifier to the caption of active hardware monitoring graphs list in *"Monitoring"* tab in the application properties. The notifier is informing you that you can apply a setting to all or to multiple selected hardware monitoring graphs when you hold group operation key (i.e. *<Shift>* or *<Ctrl>*) and hover mouse cursor over the setting that can be applied to multiple hardware monitoring graphs at once (e.g. *"Show in On-Screen Display"*)
    - Added *"Select by group"* and *"Select by type"* commands to context menu of active hardware monitoring graphs list in *"Monitoring"* tab in the application properties. New commands allow selecting the graphs of exactly the same type (e.g. CPU1-CPU8 usage graphs on eight core CPU) or the graphs with the same OSD/LCD group name (for example, GPU clock, GPU power, GPU usage and the rest graphs with *"GPU"* group name). Such commands allow you to show similar items (e.g. all CPU usages) in On-Screen Display with a single click or rename a group for all child graphs in the single pass
    - Multi group edit mode is automatically selected now for group name edit field when you enable *"Override group name"* option while holding *<Ctrl>* key. You may still manually toggle this mode with *<Ctrl>+<M>* hotkey anytime when editing the group name
    - On-Screen Display item type (i.e. text, graph or combination of both) is now displayed in *"Properties"* column of active hardware monitoring graphs list in *"Monitoring"* tab in the application properties
    - Added programmable hotkey for clearing monitoring history

- Added *"Apply"* button to application properties window. Now you may iteratively customize monitoring module without closing the properties to see the result on each step. Please take a note that some properties (e.g. application language) cannot be applied until you completely close properties window by design of application
- Application properties dialog window is now displayed with topmost style when the properties are activated from detached monitoring window and *"Always on top"* mode is enabled for it
- Now *"Mark minimum"* and *"Mark maximum"* commands are available in the context menu of monitoring window even when a fragment of history is not selected. In this case the commands result in setting tracking marker in a global extremum position. You may still use *<Shift>* key and mouse cursor to select a fragment of history then use the context menu to set tracker marker in local extremum position
- Now you may press *<F11>* key in monitoring window to capture print friendly screenshot of hardware monitoring history graphs. The screenshot includes MSI Afterburner watermark by default, you may customize it by replacing *overlay.png* file located in .*Graphics* folder. This feature can be useful for hardware reviewers
- Now you may hold *<Del>* key then click unwanted graphs in hardware monitoring history viewer mode to hide them. This feature can be useful before capturing print friendly screenshot, if you want to exclude unnecessary graphs from it
- Improved On-Screen Display layout editor:
  - System reserved variable slots 250-255 are now displayed as system variables in the layout editor
  - Added embedded graphs support. Embedded graphs can be displayed directly in the text in a separate column, it can be convenient for displaying per-core CPU usages
  - Added embedded graph width adjustment variable to the *"Graph"* property node
  - Added new *"Graph placement"* property node. You can use it to place each graph on top of text, on bottom or make it embedded in in text column
  - Added new variables to *"Separators"* property node. Now you may define independent separators for the graphs located on top of text part, for the text part and for the graphs located on bottom of text part.
  - Slightly altered interpretation of prolog and epilog separators. Please take a note that prolog separator is no longer automatically appended with new line symbol, so you must specify it manually when necessary and epilog separator is now displayed below the bottom group of graphs
  - The list of hardware monitoring items in *"Add item(s)"* dialog window is alphabetically sorted now
  - Added macroses for embedding any data from monitoring module into OSD text (e.g. prolog). You may use macroses to display anything available in the monitoring module, e.g. *%CPU temperature%*
  - Improved On-Screen Display hypertext formatting performance due to more optimal macro replace strategy
  - Revamped "modern web" layout. New layout is demonstrating new text formatting features including big custom framerate counter, custom embedded background and On-Screed Display header, custom benchmark and system time indicators and embedded CPU and GPU usage graphs
  - On-Screen Display layouts are saved in monitoring profiles now
- Improved HwInfo plugin:
  - Added UPS load, power, input voltage and charge level data sources to default plugin configuration

- Improved voltage/frequency editor:
  - Voltage/frequency editor window is now available on AMD GPUs. On AMD platform it allows you to edit core frequencies and voltages independently per each P-State:
    - Similar to NVIDIA GPUs, you may either adjust each point frequency or voltage independently with both mouse and keyboard (*<Up>* / *<Down>* or *<Ctrl>+<Up>* / *<Ctrl>+<Down>* keys), hold *<Shift>* key and drag single point to apply similar frequency or voltage offset to all P-states or hold *<Alt>* key and drag single point to add the same offset to each P-State frequency or voltage offset
    - You may press *<PageUp>* / *<PageDown>* keys to switch between frequency or voltage keyboard input focus for selected P-State
    - Read only P-States are currently not tracked, which means that you can try to adjust the frequency and voltage for locked states but changes will be ignored when applying the curve
    - P-States locking functionality is not implemented yet
  - Now you may press *<Tab>* / *<Shift>+<Tab>* keys when a point is selected to switch to the next / previous point. This feature can be useful if you're fine-tuning the offsets from keyboard
  - Now you may press *<Enter>* key when a point is selected to type in desired frequency or voltage offset for it
  - Now you may press *<Shift>+<Enter>* keys when a point is selected to type in absolute desired frequency or voltage explicitly and let the editor to calculate the offset automatically
  - Added undo/redo support:
    - Now voltage/frequency curve editor is saving up to 1024 last states of the curve during editing and allows you to undo/redo changes with *<Ctrl>+<Z>* or *<Shift>+<Y>* / *<Ctrl>+<Shift>+<Z>* keys
    - Undo history is discarded when you apply the curve
    - Number of recorded undo/redo steps is displayed in square brackets in the editor window caption
  - Slightly increased default voltage range for voltage/frequency curve. Now you may lock voltage to lower values if you're using voltage/frequency editor to downvolt and reduce power consumption on your NVIDIA GPU. Power users may customize the range further, the voltage and frequency limits are fully adjustable via the configuration file
  - Now you may press *<F5>* key in the editor window to reread the curve from hardware. This feature can be useful when adjusting the curve in changing thermal environment
  - Voltage and frequency axes are dynamically scaled now, so the captions do not overlap when window is too small

- Improved hardware control shared memory interface. During the past years, external applications like MSI Remote Server were using this interface for tuning GPU hardware settings remotely from external applications. The improvements are intended to allow connecting external stress testing and automatic overclocking related applications to MSI Afterburner via this interface:
    - Now voltage/frequency curve on NVIDIA Pascal and newer NVIDIA GPU architectures is accessible via hardware control shared memory interface
    - New hardware control shared memory interface command allows MSI Afterburner to load hardware settings from external application without immediately applying new settings to GPU
    - Added notification message, allowing external applications to notify MSI Afterburner about new command written to hardware control shared memory. Without the notification, MSI Afterburner is executing external commands on each hardware polling iteration like before. Please refer to SDK and MACMSharedMemorySample source code to see notification message usage example
    - Added hardware identification info to GPU entries in hardware control shared memory. Hardware identification info allows external applications to reconcile own enumerated devices with logical GPUs enumerated by MSI Afterburner
    - Now hardware control shared memory is refreshed on delayed fan speed readback events
- New bundled MSI Overclocking Scanner application in now included in MSI Afterburner distributive:
    - MSI Overclocking Scanner is currently supported on NVIDIA GTX 10x0 and NVIDIA RTX 20x0 series graphics cards under 64-bit operating systems only. On such systems you may activate the scanner with dedicated button from the main application window or directly from voltage/frequency curve editor window
    - MSI Overclocking Scanner is powered by NVIDIA Scanner technology, which is using proprietary algorithms to quickly and reliably test manually overclocked GPU stability or find the maximum stable GPU overclocking in automatic mode with a single click. The scanner is using embedded NVIDIA test load to stress GPU. The scanner provides you two functional modes:
        - In test mode MSI Overclocking Scanner is stress-testing your manual GPU overclocking settings during approximately 5 minutes. The result is returned as GPU stability confidence level (0% - unstable, 100% - stable)
        - In scan mode MSI Overclocking Scanner is stress-testing and slowly increasing clocks on voltage/frequency curve points and this way automatically detecting the maximum stable GPU overclocking. The result is returned as modified voltage/frequency curve and average GPU overclocking in MHz
- Added framerate limiter compatibility settings group to *“On-Screen Display”* tab to the application properties. The settings include programmable hotkeys for globally disabling, enabling or toggling framerate limiting techniques of RivaTuner Statistics Server. The settings are intended to provide a way to dynamically enable or disable scanline sync technology based framarate limiting without altering application profiles, however you may use it to toggle traditional framerate limter as well
- Now CPU topology info (i.e. each logical CPU mapping to physical CPU package and core) is displayed in system info window
- Fixed kernel mode hardware access interface fix for AMD Vega GPUs. HBM temperature, GPU power and GPU voltage are no longer returning bogus values when kernel mode hardware access interface is enabled on AMD Vega series graphics cards
- Fixed low-level GPU usage monitoring for AMD Polaris GPU family. Software SMC registers offset is no longer hardcoded, offset detection algorithm is more future proof now. Please take a note that it will not fix zero GPU load issue when *"Enable unified GPU usage monitoring"* option is enabled. This option implementation is based on low-level DirectX performance counters, which require OS and display driver WDDM versions to match. Current AMD drivers are WDDM 2.5 so this performance counter is only working when you're under WDDM 2.5 OS (Windows October Update). If you're under older OS version, this performance counter won't work unless you downgrade to WDDM 2.4 driver (18.9.3 or older)
- Hardcoded voltage/frequency curve clock multiplier implementation has been replaced with heuristic multiplier detection in order to provide unified voltage/frequency curve control implementation for NVIDIA Pascal and newer NVIDIA GPU architectures
- Improved realtime voltage/frequency curve editor GUI scaling. Now GUI is scaled property when adjusting skin scaling with open voltage/frequency curve editor window
- Improved report window, fan curve editor window, monitoring window and voltage/frequency curve editor scaling for scaling ratios greater than 100%
- Now mandatory MSI Afterburner installation option is greyed out and cannot be unchecked during installation
- Now 64-bit Visual C++ 2008 runtimes are also installed by MSI Afterburner installer. 64-bit runtimes are required for proper functionality of bundled MSI Overclocking Scanner application
- Multilanguage user interface library is DPI aware now. Main window skinned interface is no longer being scaled by OS and no longer looks blurred by default when greater than 100% DPI is selected. Now main skinned window interface can be manually zoomed with skin scaling slider in *“User interface”* tab, and the properties are automatically scaled by OS according to selected DPI
- Added new skin scaling mode for power users. New mode provides better scaling performance at the expense of some scaling image quality loss
- Skin scaling implementation is now asynchronous, so increasing skin scaling ratio doesn’t increase GUI update time and doesn’t decrease GUI response time
- Skin scaling slider range has been extended from 75%-150% to 75%-200%
- RivaTuner Statistics Server has been upgraded to v7.2.1

Version 4.5.0 (published on 24.04.2018)

- Minimum, average, maximum, 1% low and 0.1% low framerates are now displayed in On-Screen Display with special text formatting tags introduced by new RivaTuner Statistics Server. The tags are allowing On-Screen Display clients to display independent benchmark statistics simultaneously for multiple running 3D applications instead of displaying foreground 3D application statistics only
- Improved default MSI Cyborg White skin. Monochrome on / off states of fan speed auto button were hardly identifiable before, they are more contrast now
- Added power user oriented restore points system. Experienced users may use new /backup and /restore command line switches to create multiple named restore points containing full backups of MSI Afterburner's settings (including hardware profiles and custom hardware monitoring plugin configurations) and restore settings from any previously created restore point if necessary
- Improved hardware monitoring module:
    - Improved built-in performance profiler. Now you may enable *"Show profiler panel"* option is the context menu of hardware monitoring window to see additional panel with detailed per-sensor polling statistics in hardware monitoring window status area. Polling statistics visualizes information about the slowest polled sensors with maximum polling time, so power users can easily identify problematic sensors eating most of CPU time on each polling period (e.g. abnormally slow GPU power sensor in some versions of NVIDIA drivers)
    - Improved correction formulas support. Now in addition to *"x"* variable representing current data source the formulas may also use sibling data sources. For example, you may use *"x – "RAM Usage""* correction formula for *"Pagefile usage"* (commit charge) data source to subtract RAM usage from displayed value
    - Fixed incorrect tracking markers rendering on the graphs dynamically added to hardware monitoring module
    - Fixed incorrect tracking markers rendering when monitoring ring data buffer is full
    - Added experimental support for Intel i7 and i9 7XXXX LGA2066 CPUs
    - Added CPU package power monitoring for Intel CPUs
    - Minimum sampling interval for CPU usage calculation has been reduced from 1000ms to 100ms
    - Original RivaTuner's monitoring history fragment selection and selected fragment processing functionality is back! Now you may hold *<Shift>* and press left mouse button on initial desired position in hardware monitoring window to begin fragment selection, then drag mouse cursor to desired final position and release left mouse button to select a fragment. The following functionality is available for selected fragments:
        - When the fragment is selected, minimum and maximum displayed values are estimated within selected fragment only. This feature can be used if you don't need the global minimum and maximum values, estimated during whole monitoring session, and wish to see local minimum and maximum values estimated within some shorter period of time (e.g. during benchmark application runtime only)
        - When the fragment is selected you may use the context menu of any graph to set tracking marker into the local minimum or maximum position within the selection. This feature can be used to automate the process of identifying and visualizing the moments of reaching peak values (e.g. peak GPU temperature) on desired fragments
    - Improved monitoring plugins architecture:
        - Added plugin descriptions to plugins selection window
        - Added new SetupSource API function allowing you to configure the plugins. This function is allowing you to customize the plugins either globally from plugin selection window (e.g. configure whole list of data sources exported by each plugin) or customize desired data source only directly from corresponding graph properties window (e.g. change network download rate units from MB/s to KB/s). SetupSource function usage is demonstrated in SDK in updated AIDA64 and PerfCounter plugins
        - Added new GetHostAppProperty API function allowing the plugins to retrieve various properties from the host application (i.e. MSI Afterburner), e.g. retrieve GUI color scheme specific to currently selected skin. GetHostAppProperty function usage is demonstrated in SDK in updated AIDA64 and PerfCounter plugins
    - Improved monitoring plugins:
        - Now the plugins store user customized and built-in default configurations in separate files, so your custom plugin settings won't be lost on new version install
        - Added configuration GUI for AIDA64, HwInfo and PerfCounter plugins. Each plugin's user interface is allowing you to edit the list of sensors exported by each plugin, export full list of available sensors to a text file, customize each sensor's properties or reset plugin settings to defaults
        - Improved PerfCounter plugin:
            - Added support for performance counters with non-localized names (e.g. *"GPU Engine"* under Windows Fall Creators Update)
            - Added support for dynamic data sources. Dynamic data sources are not validated during creation, such sources are allowed to export no data until some condition is met (e.g. *"CPU usage"* performance counters specific to some target process export data only when the process is running)
        - Improved SMART plugin:
            - Added airflow temperature SMART attribute support for Intel/Samsung SSDs.

        - Added new CPU plugin:
            - The plugin fully duplicates MSI Afterburner's built-in CPU temperature monitoring implementation (with the only exception of AMD Ryzen codepath, which cannot be open sourced due to NDA) and shows third party plugin developers how to implement low-level CPU specific sensors in plugins using CPU MSR registers and PCI configuration space access API
        - Added new GPU plugin:
            - The plugin shows third party developers how to extend MSI Afterburner's GPU monitoring functionality and implement own GPU specific sensors in plugins using GPU enumeration and identification API. The plugin is demonstrating implementation of D3DKMT GPU performance counters providing unified vendor agnostic per-engine GPU usage, dedicated and shared memory usage monitoring
- Fixed issue in context help system, which could cause the tooltip to flicker when it was displayed below mouse cursor
- RivaTuner Statistics Server has been upgraded to v7.1.0

Version 4.4.2 (published on 18.12.2017)

- Added core voltage control for reference design NVIDIA TITAN V series graphics cards
- Added core voltage control for new revision of reference design NVIDIA GeForce GTX 1060 6GB series graphics cards
- Fixed one polling period delay for values displayed in On-Screen Display graph labels
- Improved active 3D application selection as a *"Framerate"* graph data source in cases when running multiple 3D applications are running simultaneously
- RivaTuner Statistics Server has been upgraded to v7.0.2

Version 4.4.1 (published on 09.12.2017)

- Fixed crash on application startup on the systems with more than 8 NVIDIA GPUs installed on recent NVIDIA display drivers
- Now the list of GPUs in *"General"* tab in the application properties is sorted properly on the systems with more than 10 GPUs installed
- Added voltage control for NVIDIA P104-100 and P106-100 mining cards
- Now MSI Afterburner is displaying notification message in monitoring window area when trying to overclock NVIDIA 10x0 series GPU with debug mode enabled in NVIDIA control panel
- Added *"Framerate Min"*, *"Framerate Avg"*, *"Framerate Max"*, *"Framerate 1% Low"* and *"Framerate 0.1% Low"* graphs to hardware monitoring module. The graphs are duplicating benchmark statistics displayed in benchmark On-Screen Display, but give you more freedom in On-Screen Display customization
- Improved On-Screen Display layout editor. Now you can customize On-Screen Display graph styles independently for each graph instead of changing it globally
- RivaTuner Statistics Server has been upgraded to v7.0.1

Version 4.4.0 (published on 01.11.2017)

- Added core voltage control for reference design NVIDIA GeForce GTX 1070 Ti series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GT 1030 series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX TITAN Xp series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 1080 Ti series graphics cards
- Added support for NVIDIA GPUs working in TCC (Tesla Compute Cluster) mode
- Hardware abstraction layer architecture has been revamped to allow implementation of memory temperature sensors via direct access to GPU on-die voltage controllers (e.g. AMD Vega 10 SMC) in addition to previously supported external memory temperature sensors connected to GPU via I2C bus
- Added AMD Vega 10 graphics processors family support
- Added core voltage control for reference design AMD Vega series cards with on-die SMC voltage controller
- Added GPU power draw graph to hardware monitoring module for AMD Vega series graphics cards
- Added HBM memory temperature graph to hardware monitoring module for AMD Vega series graphics cards
- Added linear RPM-based fan speed control for reference design AMD Vega series graphics cards. Please take a note that traditionally fan speed adjustment scale is not linear and it is not directly mapped to RPM, traditional fan speed percent on other hardware is a

PWM duty cycle. AMD Vega fan controller doesn't support duty cycle based fan control mode, so specified fan speed percent is linearly mapped to maximum RPM percent

- Improved voltage offset calculation accuracy for AMD Fiji, Ellesmere and Baffin GPU families
- Improved voltage offset programming reliability on AMD Ellesmere and Baffin GPU families
- Minimum voltage offset has been extended to -200mV for AMD Fiji and Ellesmere GPU families
- Fixed stuck GPU usage and memory controller usage monitoring on AMD Radeon RX 500 series under 17.6.1 and newer drivers
- Revamped voltage control layer gives additional freedom to extreme overclockers with new custom design MSI graphics cards with Quad Overvoltage™ technology support. Now MSI Afterburner is able to control up to 4 independent voltages on custom design MSI graphics cards
- Improved 5-channel thermal monitoring module architecture provides support for up to 20 independent thermal sensors per GPU (up to 5 independent GPU, up to 5 independent PCB, up to 5 independent memory and up to 5 independent VRM temperature sensors) on future custom design MSI graphics cards
- Added NCT7802Y thermal sensors support to provide compatibility with future custom design MSI graphics cards
- Added core, memory, auxiliary PEXVDD and auxiliary 1V8 voltage control for custom design MSI GTX1080Ti Lightning Z series graphics cards with IR3595A+IR3570B+uP1816 voltage regulators
- Added VRM, VRM2, VRM3, VRM4 and PCB temperature monitoring for custom design MSI GTX1080Ti Lightning Z series graphics cards with NCT7511Y thermal sensors
- Improved hardware database format. New database subsections support provides more compact database definition for multiple graphics card models sharing similar hardware calibration info
- New cached I2C device detection algorithm improves application startup time on the systems with multichannel voltage controllers or multichannel thermal sensors
- Improved third party voltage control mode functionality. Now third party hardware database can also include extended thermal sensors calibration and mapping info for third party custom design graphics cards
- Added AMD Overdrive Next X2 overclocking API support for AMD Crimson 17.7.2 display drivers
- Unofficial overclocking mode is currently broken in AMD Crimson 17.7.2 display drivers, so MSI Afterburner is forcibly disabling unofficial overclocking mode and always using official ADL overclocking codepath on 17.7.2 and newer drivers. However, unofficial overclocking mode can still be manually unlocked via configuration file on 17.7.2 and newer drivers if AMD decide to provide a fix for unofficial overclocking mode in the future
- Improved PCI bus scanner provides support for low-level GPU access for the secondary graphics cards in Crossfire configuration on some platforms
- Fixed system freeze issues when starting MSI Afterburner on AMD Hawaii GPU while playing hardware accelerated video
- Fixed issue with opening wrong graph properties under certain conditions when right clicking a graph in hardware monitoring window and selecting *"Properties"* command from the context menu
- Improved voltage/frequency curve editor for GPU Boost 3.0 capable NVIDIA graphics cards:
    - Toggling locked curve point state with *<L>* key is working properly now and no longer resulting in setting a lock to a minimum clock/frequency point
    - Now you may hold *<Alt>* key while adjusting the offset of any point with mouse to move the curve up/down. That's equal to adding fixed offset to each point's offset
- Various parts of hardware monitoring module have been pumped up to improve hardware monitoring usability and flexibility. Some new portions of old hardcore functionality from original RivaTuner are now available in MSI Afterburner:
    - Added clock monitoring for Intel CPUs
    - CPU temperature graph is now displaying data from dedicated package sensor on modern Intel CPUs instead of maximum core temperature. On older Intel CPUs with no dedicated package sensor the graph is still displaying the maximum core temperature
    - Added temperature and clock monitoring for AMD Ryzen CPUs
    - Added new *"Benchmark"* tab allowing you to use hidden RivaTuner Statistics Server's benchmarking engine, which was previously available to reviewers only. The engine is providing you the following features:
        - You may define a hotkey for beginning framerate statistics recording. Once the recording begun, it stays active for all subsequently started 3D applications, even after rebooting the system
        - While recording is active you may enable showing own statistics in RivaTuner Statistics Server to see minimum, average and maximum framerate in the On-Screen Display
        - While recording is active you may press *"Begin recording"* hotkey one more time to restart the recording and reset the statistics
        - While recording is active you may press *"End recording"* hotkey once to end recording and save benchmark results to a text file, but keep the results shown in On-Screen Display. You may press the hotkey one more time to hide the results from the On-Screen Display
        - Statistics saved to a benchmark results file includes per-application total benchmarking time, total rendered frames number, global average, instantaneous minimum and instantaneous maximum framerates. Benchmark statistics file can be optionally either overwritten or appended on each recording session
        - Per-frame frametime statistics is being pushed to a named pipe so reviewers can use their own client software to collect and display it in realtime while any benchmark is running without system slowdown, which is typical for traditional per-frame frametime logging approach
    - New flexible On-Screen Display customization features powered by RivaTuner Statistics Server's text formatting tags and embedded objects:

- Added On-Screen Display layouts support. Layouts allow you to change On-Screen Display formatting and appearance style. Now you may switch between traditional classic On-Screen Display layout or new modern column-oriented On-Screen Display layout. Built-in layout editor allows you to customize pre-defined layout parameters in details
- New On-Screen Display item type selection settings allow you to display each item in On-Screen Display as a text or graph. The graphs displayed in the On-Screen Display can be useful to visualize frametime history and GPU usage history, and so on
- The maximum text length for *"Override group name"* setting is no longer limited by 8 symbols. Now you may embed new RivaTuner Statistics Server's text formatting tags directly into your custom group name, e.g. "<C=FFFFFF>GTX 1080<S=-50>1<S><C>" to display it in On-Screen Display in white color and with 50% size subscript index
- Now it is allowed to override group names for *"Framerate"* and *"Frametime"* graphs, so you may append default application 3D API *<APP>* tag with some custom text or replace it completely if necessary
- Exactly the same flexible level of On-Screen Display customization output is available to any other RivaTuner Statistics Server client applications like AIDA, HWiNFO and others and will be available shortly

- Original RivaTuner's task scheduler functionality is back! Now you may define optional minimum and (or) maximum thresholds for any graph in hardware monitor module to track the most critical hardware health parameters, to be notified on reaching a critical threshold and to program some emergency actions (e.g. system shutdown) to be performed in this case:
  - User defined thresholds are displayed on each graph to allow you to control each parameter safety zone visually
  - When the threshold is reached blinking warning icon is displayed in top left corner of monitoring window and in Logitech keyboard LCD if graph LCD display mode is selected
  - When the threshold is reached you can see the name of graph triggering the alarm in hardware monitoring status line
  - When the threshold is reached background of the graph triggering the alarm is highlighted with color to allow you to identify it visually
  - When modern On-Screen Display layout is selected, parameters triggering the alarm are highlighted by color in On-Screen Display to allow you to identify it easily
  - You may enable option alarm sound notification to be played when the threshold is reached
  - You may configure MSI Afterburner to launch any external application when the threshold is reached. This feature allows you to implement many different scenarios, e.g. perform emergency system shutdown or apply safe profile with reduced overclocking, maximized fan speed etc. In addition to selecting any custom external applications, built-in predefined applications browser allows you to select some common typical usage scenarios, such as command line based MSI Afterburner profile activation or system shutdown
- Original RivaTuner's user extendable hardware monitoring plugins architecture is back! Now you may extend the list of hardware monitoring data sources with built-in or third party plugin modules, develop your own plugins to provide support for custom hardware sensors and share your work with community, and many more:
  - The plugins can use full set of MSI Afterburner's low-level hardware access functionality: enumerate GPUs, access GPU registers, enumerate GPU I2C buses and access I2C devices, access CPU MSR registers, access IO ports and PCI configuration space registers. This way you can easily create your own plugins providing hardware monitoring functionality for any custom hardware. You can also create the plugins for importing OS-specific or third-party software specific performance counters into MSI Afterburner
  - Open source SDK, demonstrating hardware monitoring plugins development principles to third party programmers. The SDK includes the following open source plugins:
    - SMART.dll – demonstrates HDD SMART attributes readback and HDD temperature monitoring
    - PerfCounter.dll – demonstrates the principles of importing native OS performance counters into MSI Afterburner. The list of imported performance counters includes but not limited to hard disk usage, hard disk read and write rates, free disk space on system partition, network download and upload rates. You may also add any other performance counter visible to OS (e.g. disk queue size or some specific process CPU usage) via editing the plugin configuration file
    - AIDA64.dll – demonstrates the principles of importing sensors from AIDA64 application via shared memory interface. The list of imported performance counters includes but not limited to motherboard temperature, CPU socket temperature, CPU fan speed, CPU voltage, CPU package power, +3.3V, +5V and +12V voltages. You may also add any other sensors available in AIDA64 via editing the plugin configuration file
    - HwInfo.dll - imports sensors from HWiNFO32/64 application via shared memory interface. The list of imported performance counters includes but not limited to motherboard temperature, CPU socket temperature, CPU fan speed, CPU voltage, CPU package power, +3.3V, +5V and +12V voltages. You may also add any other sensors available in HWiNFO32/64 via editing the plugin configuration file. Please take a not that the plugin is not open source per HWiNFO developer request

- Improved profiles architecture. Now MSI Afterburner can store hardware monitoring module settings in the profile slots. This allows you to switch between different On-Screen Display configurations on the fly with hotkeys bound to profile slots. You may configure desired profile slot contents in new *"Profile contents"* settings group in *"Profiles"* tab
- Added experimental interleaved hardware polling mode, aimed to reduce hardware polling time on the systems with multiple polled I2C devices. When interleaved polling is enabled, just a part of hardware monitoring data sources is being polled on each hardware polling period, so it takes multiple periods to refresh all monitoring data sources. Power users may enable interleaved hardware polling mode via the configuration file if necessary
- Added ability to define a hotkey for hardware monitoring logging start and stop
- Now the path to hardware monitoring logs supports macro names:
  - You may use new %ABDir% macro in the path to specify relative path to current MSI Afterburner installation directory. This macro allows you to use logging if you are using portal installation and start MSI Afterburner from removable drive
  - You may use new %Time% macro in the path to make hardware monitoring sessions to be stored in unique timestamp-named log files instead of single multi-session log file
- Changed hardware monitoring properties layout, the controls have been reordered a bit to give more compact and convenient look to the properties
- Changed default hardware monitoring graphs order. GPU related graphs have been reordered a bit in order to provide more convenient layout on multi-GPU systems. *"Framerate"* and *"Frametime"* graphs have been moved to the bottom of the list
- Now you may right-click the list of active hardware monitoring graphs and select *"Reset order"* command from the context menu to restore default active hardware monitoring graphs order
- The maximum limit for *"Frametime"* graph has been decreased to 50ms (20 FPS) by default
- Improved drag and drop implementation for the list of active hardware monitoring graphs. Now it is possible to drag and drop items below the bottom edge of the list to move the graphs to the end of the list
- Improved multiple selection functionality:
  - Now you may hold *<Shift>* key when clicking a checkmark next to a graph name in the list of active hardware monitoring graphs to enable or disable all graphs at once
  - Now you may hold *<Shift>* or *<Ctrl>* keys to select multiple items in the list of active hardware monitoring graphs. The following functionality is available for multiple selected hardware monitoring graphs:
    - Multiple selected graphs can be dragged and dropped when rearranging the graphs
    - When multiple hardware monitoring graphs are selected, you may hold *<Ctrl>* key when changing graph specific On-Screen Display, Logitech keyboard LCD and tray icon related properties (e.g. *"Show in On-Screen Display"* property) to change it synchronically for all selected graphs
    - When multiple hardware monitoring graphs are selected, you may hold *<Ctrl>* when clicking a checkmark next to a graph name in the list of active hardware monitoring graphs to enable or disable all selected graphs at once
    - When multiple graphs are selected you may press *<Ctrl>+<M>* inside group name edit field to apply group name changes synchronically to all selected graphs
  - Now *"Override graph name"* and *"Override group name"* checkboxes are also affected by multiple selection functionality, so you may hold *<Shift>* when toggling those options to toggle it synchronically for all graphs or hold *<Ctrl>* when toggling those options to toggle it synchronically for all selected graphs
- Improved system information window. Now 3D API usage info, x64 and UWP application architecture attributes are displayed for each currently running process in the list of active 3D applications
- Now the installer is preserving installation path
- RivaTuner Statistics Server has been upgraded to v7.0.0

Version 4.3.0 (published on 27.10.2016)

- Added AMD Ellesmere and Baffin graphics processors families support
- Added Overdrive N (Overdrive 7) technology support for AMD Polaris architecture based graphics cards
- Added core voltage control for reference design AMD RADEON RX 460, AMD RADEON RX 470 and AMD RADEON RX 480 series cards with on-die SMC voltage controller
- Added memory controller usage graph to hardware monitoring module for AMD graphics cards. Currently memory controller usage monitoring is implemented for AMD Ellesmere and Baffin graphics processors families only
- Added GPU power draw graph to hardware monitoring module for AMD graphics cards. Currently GPU power draw monitoring is implemented for AMD Ellesmere and Baffin graphics processors families only
- Added *"Erase autosaved startup settings"* option to *"AMD compatibility properties"* section in *"General"* tab. Starting from AMD Crimson drivers family, the driver is automatically saving hardware settings (e.g. overclocking or fan control settings) in the registry and apply it at Windows startup. It makes settings of any third party hardware overclocking tool virtually permanent, meaning that applied settings stay in the system even after rebooting or powering down the system. However, such implementation is unsafe and even potentially dangerous, because you're no longer able to undo unsafe overclocking with system reboot or even driver reinstall.

To prevent such situations, MSI Afterburner can now optionally erase AMD driver's autosaved startup settings after applying new settings to hardware

- Added GPU Boost 3.0 technology support for NVIDIA Pascal graphics cards:
    - Added percent based overvoltage support
    - Added voltage/frequency curve customization support. You may use traditional core clock slider on NVIDIA GeForce GTX 1070 and 1080 graphics cards to apply fixed offset to all voltage/frequency curve points as well as use brand new flexible voltage/frequency curve editor window for more precise per-point curve adjustment. The editor window can be activated either with "*Voltage/frequency curve editor"* button in the main application window or with *<Ctrl>* + *<F>* keyboard shortcut and it provides you the following features:
        - You may independently adjust clock frequency offset for each point with mouse cursor or *<Up>* / *<Down>* keys
        - You may hold *<Ctrl>* key to set anchor and fix clock frequency offset in minimum/maximum voltage point and adjust the offset of any other point with mouse to linearly interpolate the offsets between the anchor and adjustment points
        - You may hold *<Shift>* key while adjusting the offset of any point with mouse to apply the same fixed offset to all points. That's equal to adjusting the offset with the slider in main application window
        - You may press *<Ctrl> + <D>* to reset offsets for all points
        - You may switch between traditional core clock control slider in the main window and voltage/frequency curve editor window to see how they affect each other in realtime
        - You may press *<L>* after selecting any point on the curve with mouse cursor to disable GPU dynamic voltage/frequency adjustment and lock the voltage and core clock frequency to a state defined by the target point. This feature allows you to test graphics card stability independently for each voltage/frequency point of the curve using real 3D applications or any stress test of your choice. In addition to stability testing usage scenario, MSI Afterburner allows you to save a curve with locked point setting to a profile, so you may easily switch between dynamic voltage/frequency management and fixed voltage/frequency settings in realtime (e.g. to achieve the maximum performance during benchmarking). Please take a note that fixed voltage and frequency settings do not allow you to disable power and thermal throttling
- Increased default maximum limits for "*Core clock"*, "*Memory clock"* and "*Memory usage"* graphs to improve graphs readability on NVIDIA Pascal series graphics cards
- Added configuration file switch, allowing you to toggle the source for *"Power"* graph on NVIDIA graphics cards. Normalized total power draw (i.e. normalized value from multiple power sensors installed on the graphics card) is selected by default per NVIDIA recommendation, however you can configure MSI Afterburner to display power draw from GPU sensor only
- Improved representation of performance limits graphs for NVIDIA graphics cards per NVIDIA recommendations:
    - *"Voltage limit"* and "*OV max limit"* graphs have been merged into single "*Voltage limit"* graph
    - *"Utilization limit"* graph has been renamed to "*No load limit"* graph
    - *"SLI sync"* graph is now hidden on the systems with single NVIDIA GPU
    - Improved representation of performance limits graphs in On-Screen Display or in Logitech keyboard LCD. Now the names or currently triggered performance limits are being displayed in On-Screen Display or in Logitech keyboard LCD instead of previously used binary limits representation form
- Community-created third party hardware database providing voltage control support on some non-MSI custom design graphics cards is now included in distributive
- Added uP1816 voltage regulators support to provide compatibility with future custom design MSI graphics cards
- Improved validation and handling of erroneous data reported after TDR or during runtime driver installation on NVIDIA graphics cards
- Improved clock monitoring on GPU Boost 2.0 NVIDIA graphics cards after dynamic uninstallation/reinstallation of display driver during MSI Afterburner runtime
- Added detection of runtime driver installation on NVIDIA graphics cards. Now MSI Afterburner is periodically checking the presence of NVIDIA driver and displaying notification message informing you that the connection with GPU is lost when the driver is being dynamically uninstalled during MSI Afterburner runtime
- Startup profile is now also affected by "*Lock profiles"* button, which means that you cannot modify or delete your startup overclocking settings while this button is pressed. This feature can be useful to protect startup overclocking settings from modification while temporarily testing various overclocking scenarios on overclocked system
- Added support for unofficial overclocking mode with disabled PowerPlay on PowerPlay7 capable hardware (AMD Tonga and newer graphics processors family)
- Added unofficial overclocking support for AMD Polaris architecture based graphics cards
- Added ability to use low-level hardware access interface on the systems with AMD graphics cards when legacy VGA BIOS image is not mapped to memory (e.g. in UEFI environment)
- Improved compatibility with the systems with both Overdrive 5 and Overdrive 6 API AMD graphics cards installed
- Added driver registry key detection for the secondary display adapters in SLI/Crossfire systems. Due to this improvement it is no longer necessary to temporarily disable Crossfire when altering some settings in *"AMD compatibility properties"* section (e.g. *"Extend official overclocking limits"* or *"Enable ULPS"* settings)
- Improved hardware polling and application startup time on ULPS-enabled Crossfire systems with AMD Fiji and newer AMD graphics processors

- Primary GPU usage is no longer cloned on all secondary GPU usage graphs on Crossfire systems when *"Enable unified GPU usage monitoring"* is enabled in *"AMD compatibility properties"*. Please take a note that only the primary GPU load is available on Crossfire systems when this option is enabled
- Updated IO driver provides more secure MMIO access interface
- Fixed bug causing the maximum value to be invisible on some hardware monitoring graphs under certain conditions (e.g. *"Framerate"* or *"Frametime"* graphs after closing 3D application)
- Added ability to define numpad keys as hotkeys when *<Num Lock>* in on
- RivaTuner Statistics Server has been upgraded to v6.5.0

Version 4.2.0 (published on 07.12.2015)

- Added AMD Fiji graphics processors family support
- Hardware abstraction layer architecture has been revamped to allow implementation of voltage control via direct access to GPU on-die voltage controllers (e.g. AMD Fiji SMC) in addition to previously supported external voltage controllers connected to GPU via I2C bus. Please take a note that direct access to AMD SMC from multiple simultaneously running hardware monitoring applications can be unsafe and result in collisions, so similar to I2C access synchronization we introduce global namespace synchronization mutex *"Access_ATI_SMC"* as SMC access synchronization standard. Other developers are strongly suggested to use it during accessing AMD GPU SMC in order to provide collision free hardware monitoring
- Added core voltage control for reference design AMD RADEON R9 Fury / Nano series cards with on-die SMC voltage controller
- Added unofficial overclocking support for PowerPlay7 capable graphics cards (AMD Tonga and newer graphics processors family). Please take a note that unofficial overclocking mode with completely disabled PowerPlay is currently not supported for PowerPlay7 capable hardware
- Added version detection for AMD Radeon Software Crimson edition. Please take a note that new AMD Radeon Software versioning scheme is not backward compatible so now Catalyst version can be reported improperly if you reinstall older versions of Catalyst drivers on top of AMD Radeon Software Crimson edition without cleaning the registry up. Until the issue is addressed inside AMD Radeon Software Crimson edition installer, MSI Afterburner is providing compatibility switch *"LegacyDriverDetection"* in the configuration file allowing you to use legacy driver version detection mechanism if you're rolling back to legacy Catalyst drivers after AMD Radeon Software Crimson edition drivers
- GPU usage monitoring filtering algorithms, aimed to filter GPU usage monitoring artifacts in AMD ADL API on AMD Sea Islands GPU family are now disabled by default. Filtering algorithms can still be enabled by power users via configuration file if necessary
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX980Ti Lightning series graphics cards with IR3595A+IR3567B voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI GTX980Ti Lightning series graphics cards with NCT7511Y thermal sensors
- Now SDK includes detailed documentation for third party hardware database format, allowing experienced users to add voltage control support for custom design non-MSI graphics cards
- Temperature monitoring for AMD Family 10h – 16h micro architecture CPUs is no longer experimental. Now thermal monitoring on such CPUs is unlocked by default
- Slightly altered VRAM usage monitoring implementation for AMD and Intel graphics cards. Now total resident bytes are being displayed as VRAM usage instead of total committed bytes, and allocated blocks are no longer being rounded to 1MB boundary per block when calculating a total value
- Improved skin engine. Added support for altered USF skins obfuscation scheme used in most recent versions of third party overclocking tools
- Added Brazilian Portuguese localization
- RivaTuner Statistics Server has been upgraded to v6.4.1

Version 4.1.1 (published on 28.05.2015)

- Added core voltage control for reference design NVIDIA GeForce GTX TITAN X series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 980 Ti series graphics cards
- Now core voltage control via NCP4206 is unlocked on reference design NVIDIA GeForce GTX 690, NVIDIA GeForce GTX 780 and NVIDIA GeForce GTX TITAN series graphics cards when extended MSI voltage control mode is selected
- Added new third party voltage control mode. Traditionally we provided voltage control on reference design graphics cards or on custom design MSI graphics cards only. However, rich set of PWM controllers supported by MSI Afterburner core allows implementing voltage control on many third party custom design graphics cards as well. With this version we introduce original concept of user extendable voltage control mode, allowing experienced users to get access to programmable MSI Afterburner core,

get access to full range of voltage controllers supported by it, create custom hardware database and program MSI Afterburner to provide voltage control on many third party custom design graphics cards. Third party voltage control mode requires populating and downloading third party hardware database, please visit MSI Afterburner discussion forums to help adding your custom design cards to the database or download the latest database version

- Fixed bug causing application to crash when *"layered with alpha"* skin composition mode is selected, application is minimized to system tray and properties are accessed via the context menu of detached monitoring window
- Improved hardware monitoring module:
    - Added negative temperatures monitoring support for NVIDIA GPUs
    - Fixed extended CPU family and model detection to address issue with incorrect maximum junction temperature (Tjmax) detection on some Intel CPUs
    - Now power users can override the maximum junction temperature (Tjmax) via configuration file if necessary
    - Added temperature monitoring for AMD Family 10h – 16h micro architecture CPUs. Please take a note that this functionality is currently experimental and disabled by default. Power users can unlock AMD CPU temperature monitoring via *[CPUHAL]* section in the configuration file if necessary
    - Added correction formulas support. Now you can apply a custom correction formula to any data source in hardware monitoring module. Correction formulas can be useful to apply temperature offsets to custom temperature sensors if necessary (e.g. set formula to *"x+20"*), display effective memory clock instead of base clock (e.g. set formula to *"x*2"*), display per-GPU memory usage instead of total memory usage on Crossfire systems (e.g. set formula to *"x/2"*) and many, many more
    - Hardware Monitoring Log file format has been upgraded to v1.5 to provide correction formulas support
    - Added *"CPU load"* graph to multicore CPUs. The graph is displaying the average CPU load across all CPU cores
    - Added *"CPU temperature"* graph to thermal monitoring capable multicore CPUs. The graph is displaying the maximum CPU temperature across all CPU cores
    - Added connection retry counter to Logitech LCD monitoring module. Now MSI Afterburner stop trying to connect to Logitech LCD after some failed connection attempts instead of trying to connect to it in endless loop. Retry counter implementation is aimed to bypass the problem with GDI resource leak in Logitech LCD API, which could cause application to crash after some period of time when output to LCD is enabled on the system with no Logitech LCD connected to it
    - Added dynamic output format for min / max limits displayed on the graphs. Now MSI Afterburner uses integer output format for limits if the range between minimum and maximum limits is greater than 1, otherwise it uses floating point output format
- Improved skin engine:
    - Added support for altered USF skins obfuscation scheme used in most recent versions of third party overclocking tools
    - Drastically reduced load time for obfuscated USF skin files (*.UXF). Now MSI Afterburner open obfuscated skin files roughly 10 times faster than the previous version
    - Reduced skinned GUI initialization time due to cached access to the skin header
    - Added support for negative GPU temperature indicators in all skins supplied with application
- Multimedia timer resolution is no longer hardcoded to 10ms. The resolution is now adjustable and set to 16ms by default to reduce timer interrupts related CPU load at the cost of losing some smoothness in GUI animation. Power users can override timer resolution via the configuration file if necessary
- Updated kernel mode driver provides new IOCTLs for safe access to PCI bus required for temperature monitoring on AMD CPUs

Version 4.1.0 (published on 22.12.2014)

- Brand new user interface skins by Drerex Design. New skins use improved skin format introduced in the previous version of MSI Afterburner skin compiler, which reduces each compiled skin size by factor of 10 on average. Legacy MSI Afterburner v2 and v3 skins were also recompiled in new format and included in distributive for those who prefer old-style user interface
- Improved hardware monitoring module, new robust hardware monitoring features have been ported from original RivaTuner hardware monitoring module:
    - Added integrated viewer for native RivaTuner Hardware Monitoring Log (*.HML) files. Now you can view hardware monitoring history stored in HML files either by pressing *"View"* button in *"Monitoring"* tab or directly open HML files via Windows explorer
    - Added custom tracking markers support. Now you can hold <*Alt*> key while clicking hardware monitor window to set up to 8 custom tracking markers in desired positions
    - Now you can customize graph color in layered mode via double clicking color legend box on the graph
    - Now tracking markers display current values for all graphs in layered mode instead of active graph only
    - Improved graphs resizing implementation for attached hardware monitor window
- Improved skin browser:
    - Now *"User interface"* tab open immediately without waiting for processing of all installed skin files, which can be time consuming if you have a lot of skin files. The list of installed skins is now being populated in separate background thread

    - Added precaching for skin preview images. Skin files are no longer being accessed when switching between skins in the browser
- Improved skin engine:
    - Improved skin rendering performance for layered skin composition mode with alpha channel
    - Improved rendering performance for skins using animated indicators (e.g. animated profile save indicator in default MSI Afterburner skin)
    - Added backbuffering support to skinned windows to simplify implementation of various framebuffer processing related effects (e.g. skin scaling)
    - Vector indicators are now being rendered via GDI+ to provide improved antialiasing and rendering performance
    - Added support for obfuscated USF format, which is represented by some unfair competitors as 100% in-house development. Now you can use MSI Afterburner's built-in skin decompiler to analyze source code of such skin files
    - Added skins scaling support. The scaling may improve the appearance of some small third party skins on high resolution monitors. Please take a note that upscaling may reduce the performance a bit
- Improved skin cross-compatibility layer:
    - Extended list of applications supported by skin cross-compatibility layer. Now MSI Afterburner supports USF skins created for any version of third party overclocking tools starting from minimalistic oldschool skins from GeForce 200 series overclocking era and ending by obfuscated USF skins used in modern overclocking tools
    - Added support for 10 profile slots in skin cross-compatibility mode
    - Now it is possible to open advanced settings window with *<Ctrl>* + *<S>* keyboard shortcut to provide compatibility with third party skins having no dedicated button for accessing advanced settings window
    - Now it is possible to open info window with *<Ctrl>* + *<I>* keyboard shortcut to provide compatibility with third party skins having no dedicated button for accessing info window
- Added configuration file switch allowing power users to invert colors in text mode for Logitech keyboard LCD displays
- Added silent installation scenario support
- Ukrainian localization has been seriously revamped by www.overclockers.ua community
- RivaTuner Statistics Server has been upgraded to v6.3.0

Version 4.0.0 (published on 04.09.2014)

- Added AMD Tonga graphics processors family support
- Added core voltage control for reference design AMD RADEON R9 285X series graphics cards with NCP81022 voltage regulators
- Added official overclocking limits extension support for AMD Tonga graphics processors. Please take a note that unofficial overclocking mode is currently not supported for AMD Tonga graphics processors family
- Various parts of hardware monitoring module have been pumped up to improve hardware monitoring usability and flexibility:
    - Added layered monitoring graphs rendering mode. Now you may right click source graph in monitoring window, select *"Attach"* in the context menu then point to destination graph to attach source graph to it and create a group of layered graphs. This feature allows you to render as many layered graphs on the same grid as you wish. The colors of graphs in layered rendering mode can be customized independently of each other so you can easily identify them
    - Added multi-column monitoring graphs rendering mode. Now you can adjust the number of graph columns in *"Active monitoring graphs"* section in *"Monitoring"* tab
    - Added *"Override graph name"* option to *"Monitoring"* tab. Now you can rename the graphs displayed in hardware monitoring window
    - Monitoring history buffer size is no longer defined by monitoring window width. Now pre-history buffer size is fixed and stores the last 3600 samples (1 hour for 1000ms polling period) for each graph
    - Improved tray icon monitoring module:
        - Now you can select either text mode or barchart indicator mode for each value displayed in tray icon. Barchart indicator mode can be extremely useful for visualizing data like GPU / CPU usage
    - Improved Logitech keyboard LCD monitoring module:
        - Ported to new Logitech API to provide support for newer Logitech LCD displays
        - Added support for color LCD display of Logitech G19/G19s keyboards
        - Added graph mode support for color LCD display of Logitech G19/G19s keyboards. Now in addition to previously available text mode you can optionally select graph mode and see exact copy of MSI Afterburner's monitoring graphs displayed directly inside the keyboard LCD. You can also press *"Menu"* soft button on your Logitech G19/G19S keyboard to toggle between text and graph modes dynamically in realtime
        - Added acceleration support to LCD scrolling implementation
        - Added larger 8x12, 10x12, 12x12 and 12x16 fonts support for text mode
- Added *"Regional settings"* section to *"User Interface"* tab:
    - Temperature format settings allow you to switch between Celsius and Fahrenheit format for monitored temperatures. Please take a note that this setting affects temperature readouts only. Hardware related temperature adjustments (e.g. fan speed to temperature mapping curve for all cards or temperature target adjustment for NVIDIA Kepler series) are always being displayed and adjusted in Celsius for maximum unification, safety and compatibility

    - 12 hours / 24 hour time format settings allow you to configure time format for On-Screen Display and hardware monitoring window
- Added *"Enable low-level IO driver"* option to the *"Compatibility properties"* section in *"General"* tab
- Added SLI sync performance limit graph for release 340 and newer NVIDIA drivers
- Display device enumeration implementation has been modified slightly to allow monitoring Intel iGPUs when low-level IO driver is not enabled
- Improved handshaking algorithm reduces the risk of seeing multiple running instances of child processes (e.g. RTSS)
- Optimized hardware polling for NVIDIA graphics cards
- Optimized hardware polling for multi-GPU systems
- Added SVI2 voltage control support via AMD ADL SDK to provide compatibility with future graphics cards
- Added automatic prerecording settings to *"Videocapture"* tab. When you enable automatic mode prerecording session is being started automatically on each 3D application startup. Please take a note that in this case you can still use video prerecord hotkey to stop then manually restart prerecording session if necessary
- Drastically improved skin engine:
    - Improved skin compiler gives more detailed error messages when skin compilation fails due to error in some source image file
    - Source image file format is no longer limited to 24-bit BMP files only. Now skin compiler supports all possible bit depths for BMP format and fully supports PNG format with alpha channel
    - Added built-in bitmap effect for extracting alpha-channel from PNG image files
    - Skin format has been upgraded to v1.3. New format supports alpha channel based transparency for skinned window, allowing skin designers to define semi-transparent skin areas, apply antialiasing to the skin window edges and so on
    - Added new skinned window composition modes support and *"Skin composition mode"* settings to *"User interface tab"*. New settings allow you to use one of the following modes:
        - Traditional mode – suits best for backward compatibility with existing skins and performance testing
        - Layered mode with colorkey - provides much faster rendering of skins with non-rectangular window shape and additionally allows you to adjust transparency of skinned window
        - Layered mode with alpha – provides per-pixel alpha channel support and advanced visual effects for compatible skins and also allows you to adjust transparency of skinned window
    - Skin format reference guide has been updated to v1.7 to document these changes
    - Improved implementation of rollback to default skin
    - Full skins cross-compatibility with other overclocking applications based on RivaTuner engine. Special GUI transformation layer allows you to use the skins designed for third party RivaTuner based overclocking applications and makes the process of migration to MSI Afterburner from such overclocking tools much more comfortable for you. You can keep the look and feel of your preferred overclocking application and at the same time enjoy extended MSI Afterburner's features including full range of supported graphics cards, industry leading powerful and robust monitoring module, flexible video recording features and many more
- RivaTuner Statistics Server has been upgraded to v6.2.0

Version 3.0.1 (published on 10.06.2014)

- Added core voltage control for reference design AMD RADEON R9 295X2 series graphics cards with NCP81022 voltage regulators
- Fixed hardware database for reference design AMD RADEON HD 7990 and AMD RADEON HD 290X series graphic cards
- Fixed GDI resource leak when tray icon monitoring mode is enabled
- RivaTuner Statistics Server has been upgraded to version 6.1.2

Version 3.0.0 (published on 21.05.2014)

- Ported to new VC++ compiler, new core and skin engine libraries with better extendibility
- Added Bonaire, Curacao and Hawaii graphics processors family support
- Added core and auxiliary VDDCI voltage control for reference design AMD RADEON R9 290/290X series graphics cards with IR3567B voltage regulators
- Added core voltage control for reference design AMD RADEON R7 260/260X series graphics cards with NCP81022 voltage regulators
- Added core voltage control for reference design AMD RADEON 7790 series graphics cards with NCP81022 voltage regulators
- Added NVIDIA GPU Boost 2.0 technology support for NVIDIA GeForce GTX TITAN graphics cards:
    - Added slider for temperature limit adjustment
    - Added option for linked power limit and temperature limit adjustment
    - Added option for temperature limit prioritizing

    - Added maximum voltage adjustment
- Improved NVAPI access layer architecture with better extendibility
- Improved AMD ADL access layer with Overdrive 6 support to provide compatibility with future AMD GPUs
- Added NCP4206 voltage regulators support to provide compatibility with future custom design MSI graphics cards
- Improved voltage control layer architecture provides better compatibility with automatic voltage control on NCP4206 voltage regulators
- Improved hardware monitoring module architecture with better extendibility
- Added voltage control mode selection option to the *"Compatibility properties"* section in *"General"* tab. Now you can toggle between reference design, standard MSI and extended MSI voltage control modes
- Added *"boost edition"* / *"GHz edition"* GPU type selection option for reference design AMD RADEON 7970 and AMD RADEON 7950 based graphics cards to *"AMD compatibility properties"* section in *"General"* tab
- Added GPU usage averaging algorithm for Overdrive 6 capable AMD GPUs. Now displayed GPU usage is being averaged by sliding window to smooth GPU usage artifacts occurring due to bug in AMD ADL API on AMD Sea Islands GPU family
- Added optional unified GPU usage monitoring path via D3DKMT performance counters. You may tick "*Enable unified GPU usage monitoring"* option in *"AMD compatibilities properties"* in *"General"* tab as a workaround to replace native AMD GPU usage monitoring if it is working improperly (e.g. broken GPU usage monitoring in AMD ADL API for AMD Sea Islands GPU family)
- Added temperature limit, power limit, voltage limit, maximum overvoltage limit and GPU utilization limit graphs to hardware monitoring module for release 320 and newer NVIDIA driver. The graphs help you to understand the reasons of realtime performance limitations (e.g. limiting performance due to reaching power target) on GPU Boost compatible graphics cards
- Added framebuffer, video engine and bus controller usage graphs for NVIDIA graphics cards to hardware monitoring module
- Added generic NVAPI videomemory usage monitoring for NVIDIA graphics cards unattached to Windows desktop (e.g. dedicated PhysX accelerators)
- Updated power reporting for release 320 and newer NVIDIA drivers. Now MSI Afterburner reports normalized total power according to NVIDIA recommendations
- Added CPU temperature monitoring (Intel Core 2 and newer Intel CPUs only), CPU usage, RAM usage and pagefile (commit charge) usage graphs to hardware monitoring module
- Added CPU info to *"i"* window
- Added basic monitoring for unsupported GPUs (e.g. Intel integrated iGPUs):
    - Now GPU usage and videomemory usage can be monitored and displayed in On-Screen Display on any GPU, so you can use MSI Afterburner to monitor graphics subsystem on laptops without dedicated NVIDIA/AMD GPU
    - Extended GPU usage monitoring for Intel integrated iGPUs. You can independently monitor usage of main GPU execution unit (labeled as *"GPU usage"*) and MFX unit (labeled as *"VID usage"* to keep NVIDIA-styled GPU domains naming)
- Now full list of currently active 3D processes is being displayed in On-Screen Display server info section in *"i"* window instead of one active 3D process before
- Fixed GUI issue causing vertical slider to be rendered improperly in advanced application properties window under certain conditions
- On-Screen Display text length limit has been extended from 256 bytes to 4 kilobytes
- Added predefined fan speed curves list to the *"Fan"* tab in advanced application properties. The list allows you to select default curve on all cards and additional pre-defined curves (such as silent or performance fan speed curve) on some custom design MSI graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 7x0 series graphics cards
- Added core voltage control for reference design AMD RADEON 7990 graphics cards with VT1556 voltage regulators
- Added core voltage control for reference design AMD RADEON 7870 XT graphics cards with CHL8225 voltage regulators
- Added core voltage control for cost down reference design AMD RADEON 7770 graphics cards with uP1609 voltage regulators
- Added limited core voltage control for reference design AMD RADEON 7850 graphics cards
- Added secondary voltage control loop support for CHL8214 voltage regulators to provide compatibility with future custom design MSI graphics cards
- Improved skin engine, now skinned slider controls support curved paths defined by alpha channel. Skin format reference guide has been updated to v1.6 to document new slider types support
- Fixed single tray icon mode functionality under Windows 8
- Improved single tray icon mode handling. It is no longer necessary to restart application when toggling single tray icon mode
- Now unofficial overclocking mode and official clock limits extension command line switch (XCL) for AMD graphics cards are accessible via GUI in *"General"* tab in *"AMD compatibility properties"* section
- Added *"Disable ULPS"* option to *"AMD compatibility properties"* section in *"General"* tab
- RestoreAfterSuspendedMode configuration file switch is no longer undocumented, now it is enabled by default and accessible via GUI in *"General"* tab in *"Compatibility properties"* section
- Added *"Reset display mode on applying unofficial overclocking"* option to *"AMD compatibility properties"* section in *"General"* tab. This option can be used as a workaround for infamous flickering issue, caused by bug in AMD driver
- Now MSI Afterburner displays path to driver registry key in *"i"* window
- Now MSI Afterburner displays voltage regulator model and location information in *"i"* window
- Now MSI Afterburner displays RivaTuner Statistics Server installation path and server version information in *"i"* window
- Added French and Turkish localizations
- Recompiled kernel mode driver to bypass false positive in driver verifier

- Added workaround for missing tray icon when starting application while EXPLORER.EXE is not responding
- Application tray icon is now being restored after restarting EXPLORER.EXE
- Build number is now displayed in *"i"* window and in application tray icon tooltip
- Localizable installer files for third party translators are now included in distributive in .\SDK\Localization\Installer folder
- Now power users can display graphs in hardware monitoring window in multiple columns via configuration file
- Framerate slider limit in *"Videocapture"* tab has been extended from 100 FPS to 120 FPS
- Now flashing camera icon is being displayed in the top left corner of monitoring window when video is being captured
- Added "*Use dedicated encoder server"* option to *"Videocapture"* tab
- Added prerecording settings to *"Videocapture"* tab. You can select one of the following prerecording modes:
    - Prerecord to a temporary file. This mode suits best for prerecording long videos (e.g. 10 minutes or more of H.264 video) or for prerecording videos with low compression ratio (e.g. lossless Lagarith video)
    - Prerecord to RAM. This mode suits best for prerecording short videos (e.g. a couple minutes of H.264 video) and it provides a bit better performance than prerecord to file. Also, unlike prerecord to file, prerecord to RAM minimizes writes so it can increase the lifetime of SSD if you plan to use the prerecording frequently
- Added "*NV12 compression"* to the list of available video formats to *"Videocapture"* tab. This format can be used to replace uncompressed video recording with fixed 2x compression ratio at the cost of some color information loss caused by RGB to YUV 4:2:0 color space conversion
- Added *"External plugin"* to the list of available video formats to *"Videocapture"* tab. External plugins provide hardware accelerated H.264 video encoding support for Intel QuickSync, NVIDIA NVENC and AMD VCE platforms
- Improved DirectInput hotkey handler minimizes the risk of losing hotkey functionality until application restart under certain conditions
- RivaTuner Statistics Server has been upgraded to version 6.1.1:
    - The server is no longer being distributed as a part of client applications like MSI Afterburner and EVGA Precision. Now it comes under generic RivaTuner Statistics Server name with own installer and can be optionally installed when necessary. The clients will automatically hide any server dependent functionality (such as On-Screen Display, framerate monitoring, automatic 2D/3D profiles management, screen and video capture and so on) when the server is not installed
- Now RivaTuner Statistics Server installer is being started by MSI Afterburner installer to make installation process easier for beginners. The server distributive is being copied to .\Redist\RTSSSetup.exe during MSI Afterburner installation, so you may always install it later if necessary

Version 2.3.1 (published on 23.01.2013)

- Now MSI Afterburner optionally allows you to detect VRM defaults without rebooting the PC
- Added voltage control support for UEFI GOP BIOS for MSI R7970 Lightning Boost Edition series graphics cards
- Now MSI Afterburner displays the list of assigned global hotkeys in *"i"* window
- Now MSI Afterburner properties window is resizable to provide compatibility with low-resolution desktops (less than 1280x1024 with 100% DPI)
- Added new *"Enable hardware control and monitoring"* option to compatibility properties. This option can be useful if you are using MSI Afterburner for framerate monitoring and videocapture only and don't want to risk suddenly overclocking your PC
- Added NCT7511Y thermal sensors support to provide compatibility with future MSI graphics cards
- Added workaround for possible VID rounding issues for all supported voltage generator models
- Updated Italian localization
- MSI On-Screen Display server has been upgraded to version 4.5.0. New version gives you the following improvements:
    - Improved audio mixer architecture provides better extendibility and better audio tracks synchronization when mixing multiple audio tracks in one
    - Push-To-Talk audio recording support. Now you can assign a hotkey for each audio stream and record unmuted audio only when the hotkey is pressed
    - Updated German localization

Version 2.3.0 (published on 19.11.2012)

- Added 9-bit VID support for CHL8318 voltage regulators to bypass 1.6V limit in Extreme versions of MSI Afterburner
- Fixed rounding error in VID generation for offset voltage control mode for CHL8318 voltage generators
- Now it is possible to start MSI Afterburner in limited functionality mode on the systems with no supported AMD or NVIDIA graphics card. This allows you to use hardware independent features like high-performance Predator™ video capture module on any PC, even if it is using integrated Intel graphics

- Added frametime graph to hardware monitoring module. The graph is displaying the maximum frame time on each sampling period and it is useful for detecting microstutters, which are invisible on averaged framerate graph
- All documentation is now provided in PDF format
- Added unified videomemory usage monitoring implementation for Windows 8
- Removed obsolete GPU type selection settings for some AMD graphics cards
- Removed obsolete shader clock monitoring for NVIDIA Kepler graphics cards
- Improved hardware database format, now custom design MSI graphics cards are calibrated in separate OEM file to minimize the risk of introducing typos in reference design cards definitions when updating the database
- MSI On-Screen Display server has been upgraded to version 4.4.0. New version gives you the following major improvements in Predator™ video capture module:
    - Improved RTV1 compression algorithm. New compression approach combines DXTC, RLE and uncompressed data saving algorithms and allows you to increase image quality at the cost of decreasing compression ratio, while keeping extremely fast compression performance. Please take a note that the previous RTV1 compression implementation is equal to the lowest possible 25% image quality/compression ratio balance in new implementation
    - Added 64-bit version of RivaTuner Video Codec. Now RTV1 videos are playable and editable in 64-bit applications (e.g. 64-bit Sony Vegas PRO or Adobe Premiere PRO CS6)
    - Huffman tables are no longer omitted by MJPG encoder to improve compatibility with applications using limited MJPG decoders (e.g. Sony Vegas PRO)
    - Now both 32-bit and 64-bit versions of RivaTuner Video Codec can optionally decode MJPG videos. Third party MJPG codec installation is no longer required to play or edit MJPG videos with omitted Huffman tables in some applications with limited MJPG decoding support (e.g. Sony Vegas PRO). MJPG decoder can be enabled in video capture compatibility properties
    - Multisource audio recording. Now it is possible to record audio from two independent audio sources (e.g. game audio and microphone sound) in two independent audio tracks then mix them later in video editing application (e.g. Sony Vegas PRO) or optionally mix multiple tracks in realtime during capture
    - Now it is possible to downmix multichannel audio to stereo in stereo rip and stereo mix modes. Previously available stereo rip mode simply rips front left and right audio channels from multichannel audio stream, whilst new stereo mix mode merges audio from front left, right, center and surround channels
    - WASAPI audio packets with timestamp error are no longer included into output audio stream
    - External VFW codecs support. Now in addition to built-in uncompressed, RTV1 and MJPG encoders it is also possible to encode video using external VFW codecs installed in the system. It is recommended to download, install and use Lagarith Lossless Codec for lossless video capturing or x264vfw codec for the maximum compression ratio, MSI Afterburner was developed to provide the best compatibility with these codecs
    - Video stream synchronization is now based on inserting NULL frames instead of indexing existing frames
    - Frame dropping implementation has been improved to provide compatibility with external VFW codecs using temporal compression and deltaframes
    - Now output video dimensions are always cropped to be multiples of 2 to provide compatibility with external VFW codecs
    - Now framerate is calculated on each frame with sliding 1000ms window approach instead of calculating it once per second
    - Improved rendering pipeline flushing implementation for Direct3D9 applications provides more stable framerate when capturing videos with VSync enabled
    - New dynamic Direct3D rendering pipeline flushing approach can decrease videocapture related performance hit when capturing videos in Direct3D applications with high rendering framerates
    - Added On-Screen Display support for Direct3D 10 applications in Windows 8
    - Added German localization
    - Updated profiles list

Version 2.2.5 (published on 31.10.2012)

- Updated hardware database for custom design MSI GTX660 series graphics cards

Version 2.2.4 (published on 17.09.2012)

- Core voltage control is now capped by NVIDIA VGA BIOS voltage limits on MSI N680GTX Lightning series graphics cards due to NVIDIA restrictions
- Added core voltage control for reference design NVIDIA GeForce GTX 660 series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 650Ti series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GT 650 series graphics cards

- Added core voltage control for reference design NVIDIA GeForce GT 640 series graphics cards
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX660Ti Power Edition series graphics cards with uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX660 HAWK series graphics cards with uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI GTX660 HAWK series graphics cards with NCT7718W thermal sensors
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX650Ti HAWK series graphics cards with uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX650Ti Power Edition series graphics cards with uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI GTX650 Power Edition series graphics cards with uP6262 voltage regulators

Version 2.2.3 (published on 24.07.2012)

- Revised I2C access API for NVIDIA 301.xx and newer display drivers
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N680GTX Lightning series graphics cards with CHL8318+uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI N680GTX Lightning series graphics cards with NCT7718W thermal sensors
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N670GTX Power Edition series graphics cards with uP6262 voltage regulators

Version 2.2.2 (published on 20.06.2012)

- Increased upper allowed power limit for power limit adjustment slider on some extreme editions of NVIDIA GeForce GTX 600 series graphics cards
- ATIPDLXX.DLL is no longer included in MSI Afterburner distributive
- MSI On-Screen Display server has been upgraded to version 4.3.4. New version gives you the following improvements:
    - Fixed framerate calculation for DirectX10/DirectX11 applications, which actively use presentation testing during rendering (e.g. Max Payne 3)

Version 2.2.1 (published on 14.05.2012)

- Added reference design AMD RADEON 7850 series graphics cards support
- Added NVIDIA GeForce GTX 690 series graphic cards support
- Added big editions of default and legacy skins
- Updated localizations

Version 2.2.0 (published on 19.04.2012)

- Added NVIDIA Kepler graphics processors family support
- Added GPU power consumption monitoring for NVIDIA Kepler series graphics cards
- Added core clock offset, memory clock offset and voltage offset control support for dynamic overclocking on NVIDIA Kepler series graphic cards
- Dynamic clock frequency and voltage monitoring is now performed via new NVIDIA Kepler compatible API on branch 295 and newer NVIDIA display drivers
- Shader clock control is no longer supported via default MSI Afterburner skin, the skin has been redesigned to provide convenient access to modern power control technologies (AMD PowerTune and NVIDIA GPU Boost power target) instead of outdated independent shader clock control technology. Old graphics cards owners may still get access to independent shader clock control via alternate legacy skin, included in MSI Afterburner distributive
- Added AMD Tahiti, Verde and Pitcairn graphics processors family support
- Added uP1637 voltage regulators support

- Added core and memory voltage control for reference design AMD RADEON 7970 and AMD RADEON 7950 graphics cards with CHL8228 voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7970 Lightning series graphics cards with CHL8228+uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI R7970 Lightning series graphics cards with NCT7718W thermal sensors
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7970 Power Edition series graphics cards with CHL8228+uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI R7970 Power Edition series graphics cards with NCT7718W thermal sensors
- Added core and memory voltage control for reference design AMD RADEON 7870 graphics cards with CHL8228 voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7870 Hawk series graphics cards with CHL8228+uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI R7870 Hawk series graphics cards with NCT7718W thermal sensors
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7850 Power Edition series graphics cards with uP1637+uP6262 voltage regulators
- Added core voltage control for reference design AMD RADEON 7770 graphics cards with L6788A voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7770 Power Edition series graphics cards with uP6266+uP6262 voltage regulators
- Added core voltage control for custom design MSI R7750 series graphics cards with uP6266 voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R7750 Power Edition series graphics cards with uP6204+uP6262 voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R6930 Twin Frozr III Power Edition series graphics cards with uP6266+uP6262 voltage regulators
- Now MSI Afterburner displays target VID instead of real voltage sensor reading on *"GPU voltage"* graph on graphics cards equipped with CHL8228 voltage regulators. These changes are implemented to avoid confusing the beginners and prevent the hysteria about voltage drop on AMD RADEON 7970 series graphic cards spreading across different discussion forums. Experienced users, understanding the difference between target and real voltages, may still unlock the previous real voltage monitoring mode via editing the hardware profiles
- Added core voltage control for reference design NVIDIA GeForce GTX 560 Ti 448 cores series graphics cards
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N560GTX-448 Twin Frozr III Power Edition series graphics cards with uP6218+uP6262 voltage regulators
- Added core voltage control for reference design AMD RADEON 6990 series graphics cards with VT1556 voltage regulators
- Added voltage control for custom design MSI R6790 series graphics cards with CHL8214 voltage regulators
- Added core, memory and auxiliary VDDCI voltage control for custom design MSI R6950 Twin Frozr III Power Edition series graphics cards with uP6266+uP6262 voltage regulators
- Added core voltage control for custom design MSI R6950 Twin Frozr II series graphics cards with CHL8214 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N580GTX Lightning series graphics cards with uP6218+uP6262 voltage regulators
- Added memory and VRM temperature monitoring for custom design MSI N580GTX Lightning series graphics cards with NCT7718W thermal sensors
- Added memory and VRM temperature monitoring for custom design MSI R6970 Lightning series graphics cards with NCT7718W thermal sensors
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N570GTX Twin Frozr III Power Edition series graphics cards with uP6218+uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N560GTX-Ti Hawk series graphics cards with uP6218+uP6262 voltage regulators
- Added CHL8225 and CHL8318 voltage regulators support to provide compatibility with future MSI graphics cards
- Added core voltage control for alternate revision of reference design NVIDIA GeForce GTX 570 series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 460 V2 series graphics cards
- Improved overclocking profiles format provides compatibility with NVIDIA Kepler series graphics cards. Please take a note that existing overclocking profiles (startup overclocking profile and profile slots) will be ignored and must be recreated in new version
- Improved compatibility with some smart UPS models, MSI Afterburner task is no longer being terminated by Windows task scheduler when the PC is entering suspended mode
- Added new compatibility option to *"General"* tab, allowing you to select GPU type on some graphics card models using different GPU types (e.g. low-leakage and high-leakage Cayman GPUs on RADEON 6900 series graphics cards). The option affects default reference GPU voltage and 3D voltage control path
- Now MSI Afterburner's startup daemon routine precaches VRM I2C registers state at the first Windows startup. Precached VRM state is being used to detect default voltage instead of hardcoding default voltages into the database. Please take a note that you may forcibly perform precaching later with command line switch or disable the precaching at all via configuration file if necessary and force MSI Afterburner to use the previous hardcoded database based default voltage detection

- Fixed sub-zero temperatures reading on certain custom design MSI graphics cards with LM96163 and NCT7718W dedicated thermal sensors
- Hardware abstraction layer (HAL) architecture has been improved to provide compatibility with NVIDIA Kepler graphics cards series
- Now multi-GPU overclocking and fan control settings synchronization is performed at HAL level instead of display driver wrapper level to improve HAL architecture extendibility and provide compatibility with NVIDIA Kepler graphics cards series
- Added new "Force fan speed update on each period" option to the "Fan" tab. New option may improve compatibility of software automatic fan speed control mode with some bugged display drivers, overriding manually programmed fan speed under certain conditions
- Shared control memory format has been upgraded to v2.0. New format provides power limit adjustment support and forward compatibility with NVIDIA Kepler graphics cards series
- Now it is possible to override group names for values displayed in the On-Screen Display or in Logitech keyboard LCD display
- MSI On-Screen Display server has been upgraded to version 4.3.3. New version gives you the following improvements:
    - Added audio capture support to video capture engine. The engine supports stereo audio capture via DirectSound under Windows XP and both multichannel or downmixed stereo capture via WASAPI under Windows Vista and newer operating systems
    - Primary desktop video capture support for Windows XP and newer operating systems. Please take a note that desktop video capture is not supported under Windows Vista and newer OS with Aero Glass interface enabled, so Aero Glass is being automatically disabled by the server while capturing a video from desktop. Please take a note that both desktop video capture support and forcible Aero Glass interface toggling can be disabled via the configuration files if necessary
    - Improved OpenGL On-Screen Display coordinates calculation for framebuffer coordinate space mode
    - Added custom raster 3D fonts support to On-Screen Display in addition to the previously available vector 2D / 3D fonts. On-Screen Display 3D mode rendering mode switch has been replaced with new vector 2D / vector 3D / raster 3D rendering modes tri-switch
    - Now On-Screen Display coordinates are specified in pixels instead of zoomed units
    - Now it is possible to use drag-and-drop in On-Screen Display preview window to adjust On-Screen Display position
    - Now On-Screen Display supports tabulation symbols for better appearance in conjunction with new variable width custom fonts
    - Improved desktop windows notification mechanism for faster server startup and shutdown
    - Windows Sidebar is now captured properly on desktop screenshots
    - Updated system profile template mapping rules for application profiles
    - Improved bitrate calculation in AVI file headers
    - Modified screen/videocapture progress indicator appearance
    - Fixed bug causing multiple used OSD slots to overwrite each other instead of merging the slots correctly
    - Added screencapture and videocapture support for Direct3D10 and Direct3D11 applications using framebuffers with 10-bit RGB components (e.g. Dirt 3)
    - Added screencapture and videocapture support for Direct3D10 and Direct3D11 applications using BGR framebuffers (e.g. F.3.A.R.)
    - Improved video frames timestamping approach may improve smoothness of videos captured on low framerates
    - Fixed vertex buffer overflow issue causing improper On-Screen Display rendering or crashing in Direct3D10 / Direct3D11 applications when too many items are selected to be displayed in On-Screen Display
    - Improved RTV1 codec provides better compression ratio (significantly better under certain conditions) without affecting the image quality and encoding performance
    - Added alternate RTV1 compression mode providing 1.5x - 2x better realtime compression performance at the cost of some minor image quality loss. Video quality slider is now unlocked for RTV1 format, 100% quality selects original compression mode whilst any other value selects new high performance compression mode
    - Now MSI Afterburner displays captured video file time, size, per-frame compression ratio and time in the On-Screen Display next to the video capture progress indicator when *"Show own statistics"* option is enabled in the server's properties
    - Added new profile setting "Enable compatibility with modified Direct3D runtime libraries" allowing MSI On-Screen Display Server to detect runtime function offsets dynamically on each 3D application startup. This provides On-Screen Display functionality support in applications using modified Direct3D runtime libraries (e.g. FXAA injection Direct3D runtimes)
    - Added new profile settings allowing you to limit the framerate during gaming. Limiting the framerate during gaming can help to reduce the power consumption as well as it can improve gaming experience due to removing unwanted microstuttering effect caused by framerate fluctuations
    - Now video capture clients can limit the framerate during video capture. Limiting the framerate during videocapture can improve resulting video smoothness
    - Added gamma corrected video capture support
    - Added Vector 3D On-Screen Display rendering mode support for OpenGL applications
    - Added Raster 3D On-Screen Display rendering mode support for OpenGL applications using ARB shaders (e.g. ID Software's Rage)
    - Added workaround for AMD Direct3D driver issues causing OSD to be invisible in Direct3D8 and Direct3D9 applications when using Raster 3D On-Screen Display rendering mode

    - Added workaround for AMD OpenGL driver PBO issues causing the driver to crash or perform abnormally slow during videocapture
    - Added Direct3D9Ex support (DOTA 2 and Darkness 2 demo)
    - Improved desktop windows notification mechanism eliminates unwanted beeps occurring on some systems during the server startup / shutdown
    - Added video capture compatibility setting allowing cropping output video dimensions to make them multiples of 16 to improve compatibility with some third party MJPG decoders
    - Improved tabbed text formatting provides better compatibility with custom On-Screen Display group names
    - Dedicated 1/2, 1/3 and 1/4 frame downsampling routines have been replaced with unified arbitrary downsampling routine. Now MSI Afterburner provides arbitrary frame downsampling functionality and allows selecting 360p, 480p, 720p, 900p, 1080p frame sizes for both 16:9 and 16:10 aspect ratios. Please take a note that arbitrary frame sizes list is user extendable so you may add your own custom frame sizes to the configuration file if necessary
    - Now multithreaded video capture optimization is forcibly disabled by default on single core CPUs
    - Updated profiles list
- Screen and video capture no longer stop working properly after selecting a drive root as a destination folder and restarting the application
- Now SDK includes new sample code, demonstrating On-Screen Display usage from any third party application. The sample is displaying CPU usage in On-Screen Display and provides third party developers helper object for RivaTuner-styled grouped OSD text formatting
- MSI Afterburner is no longer using native AMD ADL SDK GPU indices. Now it always sorts GPUs by PCI location to ensure that GPU indices stay the same in the system regardless of operating system, display driver version and GPU display outputs connection
- Added driver-level fan tachometer monitoring fallback for AMD graphics cards via AMD ADL SDK
- PowerTune settings are now being forcibly reapplied after changing the clocks via unofficial overclocking path to bypass bug in AMD driver causing PowerTune settings to be reset to defaults during programming PowerPlay table
- Unofficial overclocking is now ignored for inactive ULPS enabled AMD graphics cards to prevent system crashing. Please take a note that you still need to disable ULPS to control all graphics cards in unofficial overclocking mode
- Added unofficial overclocking support for AMD graphics cards unattached to Windows desktop
- Now unofficial overclocking can be enabled without typing in the EULA into the configuration file. In this case the EULA is displayed and you're forced to accept it during MSI Afterburner startup
- Added power user oriented command line switches allowing to extend Overdrive clock limits on AMD graphics cards attached to Windows desktop
- ATIPDLXX.DLL is now redistributed with MSI Afterburner to address issues with unofficial overclocking under Catalyst 12.2 and newer AMD drivers
- Improved Catalyst version detection for AMD graphics cards unattached to Windows desktop
- Improved GPU type definition format in hardware database to fix ambiguous GPU type selection on some custom design MSI graphics cards (e.g. MSI R5870 Lightning series)
- Now MSI Afterburner's startup daemon routine precaches graphics card state at the first Windows startup. Precached state is being used to improve default clocks detection and clock sliders calibration in some cases when display driver provides no trustworthy defaults detection mechanism (e.g. on AMD graphics cards in unofficial overclocking mode)
- Added unified vendor independent videomemory usage monitoring layer for graphics cards, having no generic videomemory monitoring interfaces implementation in display drivers. Unified videomemory usage monitoring layer is based upon RivaTuner's VidMem plugin technology under Windows XP and original concepts of accessing Direct3D kernel mode thunk statistics under Windows Vista and Windows 7, introduced by Mark Russinovich in ProcessExplorer 15. By default, unified videomemory usage monitoring path is enabled as primary path on AMD graphics cards and as a fallback path on NVIDIA graphics cards when generic NVAPI videomemory usage monitoring is not available (e.g. on NVIDIA graphics cards unattached to Windows desktop, such as dedicated PhysX or other GPGPU graphics cards). Power users may redefine unified and generic videomemory monitoring paths usage behaviors for both AMD and NVIDIA hardware abstraction layers via the configuration file
- Changed current value and time labels rendering Z-order in hardware monitoring graphs renderer
- Improved active monitoring graphs list control in *"Monitoring"* tab reduces list flickering when hovering mouse cursor over it
- ReadMe file is now provided in RTF format instead of plain text format
- Now beta versions display notification messages informing you that it is about to expire soon in one week or less before the end of trial period
- Added update checking system
- Added RivaTuner-styled command line interface providing direct GPU and I2C device registers access. Logical AND, OR and XOR operations are supported in addition to regular read and write operations. Now MSI Afterburner can be used by vendors for pre-production custom VRM testing and calibration
- Added new compatibility option allowing disabling low-level access to hardware. New option replaces more complex RTCore.cfg renaming related workaround for BFBC2 Punkbuster's bug
- Kernel mode RTCore driver has been upgraded to v1.6. New driver introduces RivaTuner-styled protected MMIO IOCTLs and removes outdated IOCTLs dedicated for some old and currently abandoned RTCore technology based applications (HIS iTurbo and RMClock)
- Added new compatibility option allowing using protected kernel mode low-level access to hardware instead of user mode one. This option can also be used to bypass Punkbuster related stability issues
- Now MSI Afterburner restores default hardware automatic fan control mode when logging off from Windows

- Now MSI Afterburner starts significantly faster than before due to optimized I2C devices scanning, cached database access and optimized GPU context switching in profile load routine
- Fixed RTV1 codec installation issue on 64-bit systems
- Now power users may unlock additional hidden video capture formats via the configuration file
- Now screenshot and video capture quality can be adjusted with precise 1% steps instead of 5% steps in the previous version
- Now video capture framerate can be adjusted in [1 FPS; 100 FPS] range with precise 1 FPS steps instead of [25 FPS; 100 FPS] range and 5 FPS steps in the previous version
- Added "*Single tray icon mode*" option to "*User interface*" tab. When single tray icon mode is enabled, the primary application tray icon is being replaced with hardware monitoring tray icon(s) if monitoring in system tray is enabled and MSI On-Screen Display server's icon is not being displayed in tray when the server is loaded. Please take a note that MSI On-Screen Display server's properties are still accessible via *"More"* button in *"OSD"* tab
- Now shared control memory reinitialization is initiated by delayed fan speed readback mechanism
- Now MSI Afterburner can restart itself automatically instead of displaying restart requirement notification after changing some global compatibility options, e.g. unlocking voltage control or disabling low-level hardware access interface
- Now DirectX web setup is integrated into the installer
- Skin format reference guide has been updated to v1.5 to document new indicator types support
- Now new user interface language selection into MSI Afterburner GUI also results in selecting the same user interface language into MSI On-Screen Display Server
- Updated Korean localization
- Added Simplified Chinese localization
- Added Indonesian localization
- Added Japanese localization
- Added German localization
- Added Polish localization
- Added multilanguage installer

Version 2.1.0 (published on 24.02.2011)

- Added AMD Barts and Cayman graphics processors family support
- Added core voltage control for reference design AMD RADEON 6970 graphics cards with CHL8228 voltage regulators
- Added core voltage control for reference design AMD RADEON 6970 graphics cards with VT1556 voltage regulators
- Added core voltage control for reference design AMD RADEON 6950 graphics cards with CHL8214 voltage regulators. Please take a note that voltage control is not supported on AMD RADEON 6950 graphics cards flashed with AMD 6970 BIOS
- Added core voltage control for reference design AMD RADEON 6950 graphics cards with VT1556 voltage regulators. Please take a note that voltage control is not supported on AMD RADEON 6950 graphics cards flashed with AMD 6970 BIOS
- Added core voltage control for reference design AMD RADEON 6870 graphics cards with CHL8214 voltage regulators
- Added core voltage control for reference design AMD RADEON 6850 graphics cards with CHL8214 voltage regulators
- Added core voltage control for reference design NVIDIA GeForce GTX 580 series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 570 series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 560 Ti series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 550 Ti series graphics cards
- Added core voltage control for reference design NVIDIA GeForce GTX 460 SE series graphics cards
- Added delayed fan speed readback mechanism to improve compatibility with fan control on GeForce GTX 580 series
- Added low-level fan tachometer monitoring for RV7xx and newer AMD graphics cards using on-die GPU tachometer
- Fixed low-level memory clock monitoring for some mid-range AMD RADEON 5xxx series graphics cards using QDR control related power saving technologies
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N465GTX Twin Frozr II Power Edition series graphics cards with uP6218+uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N450GTS Cyclone Power Edition series graphics cards with uP6262 voltage regulators
- Added core voltage control for custom design MSI N450GT DDR5 series with uP6262 voltage regulators
- Added core and memory voltage control for custom design MSI N430GT and N420GT series with uP6262 voltage regulators
- Fixed typo in hardware database causing regular MSI N470GTX and MSI N470GTX Twin Frozr II graphics cards to be detected as MSI N470GTX Twin Frozr II Power Edition series and causing voltage control to be locked
- Added I2C bus index filtering in uP6262 voltage regulators detection code to prevent voltage regulator detection conflicts with DDC on the systems with some specific monitor models. The conflicts resulted in displaying fake +10/+20/+30 voltages on MSI GeForce N460GTX Hawk series
- Added power user oriented configuration file switch for adjusting retry counter for external I2C voltage regulators detection. Retry counter is set to 3 by default
- Fixed bug in the context help system causing it to display wrong floating tooltips when hovering cursor over the controls under certain conditions

- Added ability to assign a hotkey for toggling the On-Screen Display Server blocking. This hotkey is aimed to provide a simple way for diagnosing the server related compatibility issues
- Changed default fan speed curve for user defined software automatic fan speed mode
- Now MSI Afterburner uses previously undocumented power user oriented DirectInput based hotkey handler. New hotkey handling mechanism drastically reduces hotkey response time in applications heavily loading CPU. Please take a note that new sophisticated hotkeys handling can cause some system security applications (e.g. KIS proactive defense module) to warn you about possible keylogging threat
- Fixed bug in hotkey handler causing it to detect false keystrokes under certain conditions
- MSI On-Screen Display server has been upgraded to version 4.0.1. New version gives you the following improvements:
    - Reduced On-Screen Display rendering related CPU performance hit due to more effective geometry batching in On-Screen Display 3D rendering mode codepath
    - Now MSI On-Screen Display server supports RivaTuner's user extendable localization system
    - Screenshot compression library SaveImage.dll has been replaced with more progressive SaveMedia.dll library providing unified screenshot and video encoding engine
    - JPEG screenshot quality settings are no longer power user oriented and can be adjusted directly from the client application GUI
    - Screen capture implementation is now multithreaded to minimize the impact on the game performance when saving screenshots on the systems with multicore CPUs
    - Text indication of screen capture events in the On-Screen Display has been replaced with graphics progress indicator
    - Fixed bug causing the On-Screen Display to be rendered in wrong colors in 3D mode in some multitextured Direct3D9 applications (e.g. several bumpmapping related samples from DirectX 9 SDK)
    - Updated profiles list
- Added high performance realtime in-game video capture support by means of built-in video capture engine of new MSI On-Screen Display server. You no longer need to waste your money on purchasing an additional video capture application, now MSI Afterburner is providing such functionality to everyone and absolutely for free! The key features of video capture engine are:
    - Realtime video capture support for any Direct3D8, Direct3D9, Direct3D10, Direct3D11 and OpenGL applications
    - Queued frame capture algorithms are aimed to minimize the graphics pipeline stalling caused by transferring pixel data from GPU to CPU and keep high and smooth in-game framerate while video capture is in progress
    - Multiple video capture formats: uncompressed video capture for the systems with high performance disk I/O subsystems, two different compression modes for the systems with both mid-range and high performance multicore CPUs
    - Multithreaded SIMD optimized encoders are aimed to provide the maximum compression performance on modern multicore CPUs with SSE2 instructions support
    - Various options allowing you to tweak video capture performance on your system: customizable target video framerate, customizable target video quality, controllable multithreaded optimization and various frame downsampling modes
    - Audio stream capture and additional video capture related enhancements are coming in future versions
- Now screen capture events are also indicated by notification messages in the hardware monitoring window
- Added option allowing hiding On-Screen Display on captured screenshots and videos
- Reduced hardware polling time on multi-GPU systems due to cached GPU context switching in hardware monitoring module
- Improved hardware monitoring shared memory layout v2.0 introduces additional data source identification related fields and new GPU descriptors array. Third party developers may refer to updated sample code included in the SDK
- Added new control shared memory interface for future MSI software products integration with MSI Afterburner. New shared memory interface allows third party applications to program graphics card clock frequencies, voltages and fans via MSI Afterburner. Such shared memory interface allows developing a lot of useful external applications, for example smartphone overclocking client applications connected to the PC server and remotely controlling the hardware via MSI Afterburner and so on. The SDK included in MSI Afterburner distributive contains open source sample demonstrating the access to new control shared memory from a third party application
- All synchronization mutexes have been moved from local to global namespace
- Now Microsoft Visual C++ 2008 runtime libraries are included in distributive and installed with software
- Hardware database is now configured to force fan duty cycle monitoring to be performed less efficient AMD ADL SDK path on AMD RADEON 4870 X2 and HD 5970 series graphics cards
- Changed way of unlocking unofficial overclocking on AMD graphics cards
- Added alternate unofficial overclocking path allowing keeping PowerPlay active on some modern ASIC families during overclocking
- Fan control settings are now being forcibly reapplied after changing the clocks via unofficial overclocking path to bypass bug in AMD driver causing the fan control settings to be reset to defaults during programming PowerPlay table
- Fixed bug in uP6266 voltage control codepath causing setting wrong fixed 0.920V voltage instead of desired one when *"Force constant voltage"* option is enabled
- Localization reference guide documentation has been updated to v1.2
- Various typo fixes in different language packs

Version 2.0.0 (published on 02.09.2010)

- Voltage control layer has been seriously revamped to give additional freedom to extreme overclockers with new custom design MSI graphics cards. Now MSI Afterburner is able to control up to 3 voltages on custom design MSI Fermi and other future custom design MSI graphics cards. New adjustable voltages include memory voltage and special multi-purpose auxiliary voltage feeding either memory bus (also known as VDDCI on AMD graphics cards) or PCIE bus and crystal (PEXVDD on NVIDIA graphics cards)
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N480GTX Lightning series graphics cards with uP6225+uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N470GTX Twin Frozr II OV3 series graphics cards with uP6218+uP6262 voltage regulators
- Added core, memory and auxiliary PEXVDD voltage control for custom design MSI N460GTX Hawk series graphics cards with uP6262 voltage regulators
- Added core voltage control for custom design MSI N460GTX Cyclone series graphics cards
- Added auxiliary VDDCI voltage control for reference design AMD RADEON HD 5870 series graphics cards
- Added fan tachometer monitoring for NVIDIA graphics cards. Please take a note that not all graphics cards are tachometer reading capable. So depending on graphics card and cooling system fan tachometer monitoring can be unavailable
- Optimized NVIDIA driver-level clock frequency monitoring codepath
- Minimum clock limits for all graphics cards have been reduced from 75% to 50%
- Dynamic overclocking, voltage and fan speed limits. MSI Afterburner no longer uses static slider limits calibration and adjusts the limits dynamically when some external factors affect it (e.g. Overdrive clock limits on AMD cards or VGA BIOS fan speed and voltage limits on NVIDIA GeForce GTX 400 cards)
- New temperature hysteresis settings for software automatic fan control mode gives you additional way to improve cooling system thermal and acoustic parameters
- Now fan speed limits (i.e. minimum and maximum fan speeds accepted by VGA BIOS and display driver) are displayed in custom fan speed curve editor window
- Built-in skin sizes have been reduced due to optimized internal skin panels representation and optimized compiled bitmap cache
- Optional skin compression ability in the built-in skin compiler. Skin format reference documentation has been updated to document new compression options
- Minor built-in skins appearance tweaks
- Now MSI Afterburner uses previously undocumented power user oriented startup mode via the task scheduler under Windows Vista / Windows 7. MSI Afterburner launch no longer requires UAC confirmation at Windows startup. Please take a note that Microsoft Visual C++ 2008 runtime libraries must be installed to get new startup mode working
- Now MSI Afterburner automatically fixes startup link if *"Start with Windows*" or *"Apply overclocking at system startup"* is enabled but the registry or task scheduler startup entry is missing
- Startup profile is now displayed in *"Apply at Windows startup*" option floating tooltip instead of the main window
- Now power users can enable optional DirectInput based hotkeys handler via the configuration file. DirectInput based hotkeys processing can seriously reduce hotkey response time in the applications heavily loading CPU (mostly 3D games) and leaving not enough time for processing standard keyboard input message queues. Please take a note that enabling such sophisticated hotkeys handling mode can cause some system security applications (e.g. KIS proactive defense module) to warn you about possible keylogging threat
- Improved skin engine, now skinned controls support horizontal and/or vertical centering. Skin format reference guide has been updated to document these new alignment modes
- MSI On-Screen Display server has been upgraded to version 3.7.2. New version gives you the following improvements:
    - Now screen capture events are identified visually by text message flashing in On-Screen Display during 0.25s
    - Built-in skin sizes have been reduced due to optimized compiled bitmap cache
    - Added On-Screen Display profile for StarCraft II : Wings of Liberty
    - *"Start the task only when computer is running on AC power"* option is no longer set in the startup task settings to allow automatically starting application via the task scheduler on laptops or on some UPS models
- Added configuration file switch allowing sending MSI Afterburner to system tray instead of closing on *"Close"* button click
- *"Start the task only when computer is running on AC power"* option is no longer set in the startup task settings to allow automatically starting application via the task scheduler on laptops or on some UPS models
- Added optional data filtering mode for all hardware monitoring graphs. Now it is possible to enable special math data filtering algorithm independently for each hardware monitoring graph to reject misreading spikes caused by sensor access conflicts when running multiple hardware monitoring tools at the same time
- Now it is possible to use both core and shader clock as the primary clock when adjusting the clocks in linked mode
- Fixed videomemory usage monitoring for non-primary NVIDIA graphics cards
- Application restart is no longer required to apply new user interface language
- Updated localization engine. Now floating tooltips based context help system supports macro definitions
- Localization reference guide documentation has been updated to v1.1
- Various typo fixes in different language packs
- Added Korean localization

Version 1.6.1 (published on 12.07.2010)

- Added NVIDIA GeForce GTX 460 series graphics cards support

Version 1.6.0 (published on 07.06.2010)

- Added NVIDIA GeForce GTX 400 series graphics cards support (including voltage control!)
- Added voltage control for MSI N240GT Low Profile series graphics cards
- Added basic screen capture support by means of built-in screen capture engine of MSI On-Screen Display server. Now it is possible to assign the hotkey for capturing screenshots in BMP, PNG or JPG formats on desktop, in DirectX or in OpenGL applications
- Added hardware monitoring history logging support. Now MSI Afterburner is able to save history in native RivaTuner Hardware Monitoring Log file format. The log files captured with MSI Afterburner can be viewed in any text editor like Notepad or in graphics form in RivaTuner's HML file viewer (RivaTuner must be installed for viewing log files in graphics form)
- Added new safety option allowing forcing constant voltage on some cards with voltage regulators supporting programmable dynamic voltage management (e.g. VT1165 or uP6266). New safety option may improve stability on some systems as well as provide power state independent voltage control on the systems with non-standard voltage control implementation
- Screen capture and On-Screen Display hotkey events are now being processed via direct connection to the On-Screen Display server instead of command line. Due to this change Screen capture and On-Screen Display visibility control hotkeys are being processed faster now
- MSI On-Screen Display server has been upgraded to version 3.7.1. New server gives you a lot of improvements including:
    - DirectX11 On-Screen Display and screen capture support
    - DirectX screen capture engine is no longer using DirectX runtimes to capture and compress screenshots. Screen capture and compression to PNG/JPG formats in DirectX applications is now handled by own more effective LIBPNG/JPEGLIB based library
    - PNG and JPG screen capture support for desktop and OpenGL applications
    - Adjustable JPG screen capture quality for experienced users
    - Screen capture support for DirectX10 and DirectX11 applications using multisampled antialiasing or non-standard frame buffer formats (e.g. sRGB)
    - Optional On-Screen Display 3D rendering mode. New mode uses 3D accelerated DirectX functions to emulate previously used 2D framebuffer access functions and render 2D text. New rendering mode provides On-Screen Display support in DirectX10 and DirectX11 applications using multisampled antialiasing and can also drastically reduce OSD related performance hit on the systems with badly optimized 2D acceleration in display drivers
    - Simplified On-Screen Display coordinate space settings. Rarely used desktop and window coordinate space modes have been merged into single framebuffer coordinate space mode
    - Now the server automatically selects framebuffer coordinate space instead of viewport coordinate space when viewport is not accessible (e.g. if pure Direct3D8 device is in use)
    - Improved application notification scheme during runtime profiles adjustment. Now runtime changes in OSD application profiles (e.g. OSD zoom ratio change on the fly) are reflected in affected application almost immediately instead of approximately 1 second delay in the previous versions
    - Reduced runtime skin engine memory footprint due to dynamic skin storage unloading
    - Improved race condition protection system for multithreaded 3D engines (e.g. Age of dragons : Origins and ArmA II)
    - Improved race condition protection system for the systems running multiple OSD applications simultaneously (e.g. OSD server, FRAPS and STEAM In-Game Chat)
    - Improved floating injection address hooking technology. Due to more advanced built-in code analyzer hooks can be injected deeper into 3D application code if stealth mode is enabled. These changes improve stealth mode compatibility with third party tools using similar stealth injection technologies (e.g. FRAPS v2.9.8 and newer)
    - Now stealth mode cannot be toggled during 3D application runtime to reduce the risk of crashing 3D application
    - Removed single screen capture per second limitation
    - Updated profiles list
- Now MSI Afterburner distributive includes original 128x128 PNG application logo (stored in .\Graphics folder) for dockbar applications like RocketDock or ObjectDock
- It is no longer necessary to close the application to save monitoring window attachment state
- *"Stop the task if it runs longer than 3 days"* option is no longer set in the task settings when using alternate startup mode via the task scheduler under Windows Vista / Windows 7
- Full list of active On-Screen Display server clients is now displayed in *"i"* window instead of the most recent client
- Floating tooltips help system is now reinitialized properly after runtime skin switching
- Added Ukrainian localization

Version 1.5.1 (published on 13.03.2010)

- Added voltage control for MSI R5830 Twin Frozr II series graphics cards

- Added voltage control for MSI R5670 Twin Frozr II series graphics cards
- Fixed voltage control for MSI R5870 Lightning and R5870/R5850 Twin Frozr II series graphics cards
- Fixed description of R5670 1GB series

Version 1.5.0 (published on 10.02.2010)

- Added videomemory usage monitoring for NVIDIA graphics cards under ForceWare 185.xx and newer drivers
- Added GPU usage monitoring for NVIDIA GT2xx and newer graphics cards under ForceWare 185.xx and newer drivers
- Added VGA BIOS version detection for AMD graphics cards
- Added optional ability to display hint messages in hardware monitoring window area. The messages notify the user about runtime profile management activity (such as profile creation, removal or applying) and other application events
- Minor appearance tweaks in default skins
- Added compact versions of default skins (default green, red and blue editions)
- Now advanced MSI Afterburner properties also support floating tooltip based context help system similar to the main application window
- Now MSI Afterburner supports RivaTuner's user extendable localization system. Currently localization system includes default English, Russian, Traditional Chinese, Spanish, Italian and Dutch language packs and affects context help system and non-skinned advanced properties interface. Similar to RivaTuner you can also create your own language packs for your native language and share your work with MSI Afterburner users' community!
- Improved skin format. Now skinned fonts support characters remapping feature. All skins supplied with MSI Afterburner are using this feature, third party skin designers may decompile and peek into these skins to see an example of new feature usage
- Now hardware monitoring window font size can be redefined via the skin, third party skin designers may decompile and peek into compact versions of default skins to see an example of new feature usage
- Skin format reference documentation has been updated to v1.1 to reflect the format improvements mentioned above
- Added shared memory interface allowing any third party applications to access MSI Afterburner hardware monitoring statistics. The interface is intended for future MSI Afterburner Vista / Windows 7 sidebar gadgets, however, the shared memory layout is publicly open so third party developers can use it to access MSI Afterburner hardware monitoring statistics from their own applications. The SDK included in MSI Afterburner distributive contains open source sample demonstrating the access to shared memory from a third party application
- Added command line switches for forcing MSI Afterburner to be minimized to the system tray area on startup or during runtime and for opening desired advanced MSI Afterburner properties tab. The switches are intended for interaction with future MSI Afterburner Vista / Windows 7 sidebar gadgets. Sample code included in the SDK also shows you how to detect, start and minimize installed MSI Afterburner, how to open desired tab in advanced properties and how to use MSI Afterburner profiles from third party applications
- Reduced runtime skin engine memory footprint due to dynamic skin storage unloading
- Startup settings are now displayed next to the *"Apply overclocking at system startup"* button
- Added button for locking profiles modification
- Now voltage control is also locked by default in safety options in advanced MSI Afterburner properties
- Added AccessibilityCheckingPeriod configuration file switch for improving the compatibility with AMD ULPS power saving technology on Crossfire systems. The switch allows low-level monitoring module to use AMD driver API to check GPU accessibility and detect and display GPU sleep state properly. Please take a note that AMD API implementation is ineffective and hardly suits to realtime monitoring due to high CPU stress resulting in periodic stuttering in games. That is why the compatibility switch is disabled by default, enable it only if you absolutely need to see slave GPU sleep state on the graphs and accept side effects like performance drop and stuttering resulting from ineffective AMD API implementation
- Added NVIDIA GT240M PCI DeviceID range to the core to provide more efficient hardware monitoring via low-level core on mobile NVIDIA GT240 based systems (bonus feature, official mobile systems support is still not declared)
- Graph limits are now adjustable in the graph properties in *"Monitoring"* tab
- Added AMD RV810 graphics processors family supports
- Added voltage control for custom design MSI R5670 1GB series graphics cards with uP6262 voltage regulators
- Added voltage control for custom design MSI R5870 Lightning series graphics cards with uP6266 voltage regulators
- Added voltage control for custom design MSI R5870 Twin Frozr II series graphics cards with uP6266 voltage regulators
- Added voltage control for custom design MSI R5850 Twin Frozr II series graphics cards with uP6266 voltage regulators
- Added integration with external MSI Kombustor stability testing application
- Added workaround for overclocking bug of ForceWare 196.21. Please take a note that the workaround is applied only to 196.00 - 196.21 driver versions range in order to ensure compatibility with future fixed NVIDIA drivers.
- Now hardware database includes marketing names of MSI graphics cards so MSI Afterburner displays marketing names instead of generic graphics card model names when possible

Version 1.4.2 (published on 07.01.2010)

- Added voltage control for custom design MSI N240GT D5 1GB series graphics cards with uP6262 voltage regulators
- Added voltage control for custom design MSI R5770 Hawk graphics cards with uP6204 voltage regulators

Version 1.4.1 (published on 23.11.2009)

- Fixed incorrect database entry for MSI N240GT D3 series graphics cards

Version 1.4.0 (published on 11.11.2009)

- Added initial AMD RADEON HD 5970 series graphics cards support
- Added voltage control for cost down reference design AMD RADEON HD 4870 series graphics cards with L6788A voltage regulators
- Added voltage control for custom design MSI R4770 Cyclone graphics cards series with uP6204 voltage regulators
- Ineffective and slow temperature, clock, GPU usage and fan speed monitoring implementation provided by native AMD's ADL SDK has been replaced with own more effective low-level codepath. Due to new codepath hardware monitoring related CPU performance hit has been reduced drastically on the systems with AMD graphics cards and drivers
- On-Screen Display and Logitech LCD monitoring modules no longer explicitly read displayed data from hardware and retrieve cached data from monitoring graphs instead. Due to this change CPU performance hit is reduced when OSD or LCD monitoring features are enabled
- Fan speed slider position and numeric fan speed input field are now being refreshed in automatic fan speed mode only when MSI Afterburner window is active
- Added configuration file switch allowing power users to unlock unofficial overclocking codepath in AMD display drivers (similar to AMDGPUClockTool, ATITool and RivaTuner overclocking implementation on AMD graphics cards). Unlike AMD's official ADL SDK overclocking ways, unofficial ones are not limited with CCC clock limit but have some alternate disadvantages (e.g. PowerPlay support limitation). Please take a note that unofficial overclocking methods are not supported either by AMD or by MSI, so unlock and use it at your own risk
- Now it is possible to toggle performance profiler status info visibility in hardware monitor window via *"Show status"* option in the context menu
- Fixed L6788A database entry for AMD RADEON HD 4770 series graphics cards
- GPU voltage monitoring feature is now locked and not available by default. Unfortunately, some inexperienced users don't understand the risk of running multiple tools accessing voltage regulator at the same time and tend to use helper voltage monitoring features in everyday hardware monitoring sessions in conjunction with third party VRM monitoring tools, intensively writing data to VRM and periodically causing it to enter wrong state due to write collision. Unfortunately, such issues are wrongly treated by certain users as instability of our product. To prevent such rumors, since this version voltage monitoring feature is no longer available to beginners by default. Experienced users understanding these specifics and accepting these risks may unlock voltage monitoring features via new safety option in *"General"* tab
- AMD RV8xx I2C microcontroller is now being forcibly reset prior to starting new I2C transaction to minimize the risk of I2C collisions with third party tool without I2C synchronization protocol support (e.g. AMDGPUClockTool)
- Added safety option allowing users to disable voltage control feature if it is not needed
- Now Afterburner forcibly changes memory clock for all performance levels at once on AMD graphics cards with equal default memory clocks defined for all performance levels to bypass flickering issue caused by incorrect PowerPlay dynamic memory clock changing implementation on some cards
- Added Catalyst driver family version detection for AMD graphics cards
- Added option to display system time in the On-Screen Display
- Added red and blue editions of default skin
- Various minor user interface and skin tweaks
- Added configuration file switches allowing power users to tweak Afterburner startup process and define startup delay or force the startup to be handled by Windows Vista / Windows 7 Task Scheduler to bypass UAC evaluation window (additional Microsoft Visual C++ 2008 runtime libraries installation is required for task scheduler based startup way)
- MSI On-Screen Display server has been upgraded to version 3.6.0. New server provides improved desktop windows notification mechanism and also features optional power user oriented task scheduler based startup way
- Added skin format reference documentation. Now third party skin designers may use this local offline documentation to create their own skins for MSI Afterburner. Official MSI Afterburner skin creation contest is approaching! Do you feel that you can design nice skins for MSI Afterburner? Stay tuned and don't miss your chance to win the prize!

Version 1.3.0 (published on 19.10.2009)

- Added voltage control for reference design AMD RADEON HD 4770 and AMD RADEON HD 5770 series graphics cards with L6788A voltage regulators
- Added voltage control for custom design MSI N240GT D3 series graphics cards with uP6262 voltage regulators
- Fixed database entry for AMD RADEON HD 4870 X2 graphics cards. Afterburner no longer adjusts 2D voltage instead of 3D voltage on AMD RADEON HD 4870 X2

Version 1.2.0 (published on 12.10.2009)

- Added NVIDIA GeForce G 210 and NVIDIA GeForce GT 240 series graphics cards support
- Added voltage control for custom design MSI N220GT D2, MSI N220GT D3 and MSI N240GT D5 series graphics cards with uP6262 voltage regulators
- Added initial AMD RADEON HD 5750 and AMD RADEON HD 5770 series graphics cards support
- Added Logitech keyboards LCD displays support. Now it is possible to display hardware monitor data in Logitech keyboards LCD
- Extended I2C address scanning range for uP6208 voltage regulators to allow supporting voltage control on non-MSI custom design graphics cards equipped with uP6208
- Fixed on-board memory size detection for AMD RADEON HD 5000 series graphics cards
- Now *"Synchronize settings for similar graphics processors"* option also affects voltage control
- Fixed database entry for AMD RADEON HD 4890 series graphics cards. Afterburner no longer adjusts 2D voltage instead of 3D voltage on AMD RADEON HD 4890
- Fixed database entry for AMD RADEON HD 5850 series graphics cards. Afterburner no longer adjusts UVD voltage instead of 3D voltage on AMD RADEON HD 5850
- Automatic profiles manager is now restarted after resuming from suspended mode
- Revised VRM access synchronization protocol for safer simultaneous VRM polling by multiple software products at the same time
- Added *"Always on top"* setting to the context menu of detached hardware monitor window. When this option is disabled, hardware monitor window can be minimized to the taskbar while staying in detached mode
- Now it is possible to pause hardware monitor activity via *"Pause"* option in the context menu of hardware monitor window
- Maximum allowed hardware polling period has been extended from 5 to 60 seconds
- Added configuration file setting allowing power users to display performance profiler status information in the hardware monitor window. The information allows estimating average CPU performance hit caused by hardware monitor and software automatic fan control layers
- Optimized timer message queue processing under high CPU load conditions for better hardware monitoring and software automatic fan control events handling
- Reduced CPU usage for simultaneous GPU clock frequency and GPU usage readings on AMD graphics cards, both values are being read in single pass now
- Maximum limits have been extended from 1000 to 1500MHz for core clock graph and from 2000 to 2500MHz for shader clock and memory clock graphs
- Added readme file and option to display it in the installer
- Now *"Fan"* tab is not displayed in advanced settings window if there are no fan control capable GPUs in the system
- Updated context help files, added more hints to *"User define"* button help

Version 1.1.0 (published on 01.10.2009)

- Added AMD RADEON HD 5850 and AMD RADEON HD 5870 series graphics cards support
- Added NVIDIA GeForce GT 220 series graphics cards support
- Fixed database entry for MSI N260GTX Lightning series graphics cards. Voltage control is no longer locked on MSI N260GTX Lightning cards
- Fixed bug causing the hotkeys to be ignored till restarting software after opening and closing advanced settings window
- Default tray icon text color has been changed from white to red to improve icon text readability in Windows 7
- Improved internal command line based I2C scanner

Version 1.0.0 (published on 17.09.2009)

- Initial version printed on CD