

CAT All Sports Hardware Specifications – 2022 v1.79

Last updated: 05/12/22 by: Chris Bashaw

Revisions:

- v1.79 Add MS188 & MS88, Latitude 7320 Tablet; Updated 3450 Graphics Card
- v1.78 Add Dell 7560 (7550 Replacement) 3450(3440 Replacement) Removed MS-68/78 Servers, Removed Media Servers
- v1.77 Add Dell 5420 (5410 Replacement), Removed Dell 6540, Dell 6530, Dell T-3600, Dell T-3610, MS35, MS36, 6540 Micro server
- v1.76 Add Cisco Router and 10Gb Switch Updates
- v1.75 Add MS-86 & MS-186 Servers with 16TB drives
- v1.74 Add Dell 7550 (7540 Replacement), 5410 (5400 Replacement), 3440 (3431 Replacement)
- v1.73 Add Dell 3431 SFF Desktop (7060 Replacement) and Surface Pro 7
- v1.72 Add Dell 7540 with WD19TB Dock (7530 Replacement)
- v1.71 Add Dell 5400 with WD19TB Dock (7490 and WD15 Dock replacement)
- v1.70 Add MS-82 Lite Server
- v1.69 Add MS-82 & MS-182 Server Family and Dell OptiPlex 7060 Small Form Factor Desktop

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CAT System Qualification Overview

CAT customers demand the highest level of reliability, stability and performance from our video and data systems. The systems we provide operate in a number of unique modes which include video capture, off-speed video playback and intense data analysis. All of these functions must occur with minimal latency across networks with multiple clients. There is little to no tolerance for video stutter, hitching or sluggishness.

The systems we specify and provide are more than off-the-shelf boxes for the casual user simply watching a movie or sharing files. The hardware that we recommend and provide has been thoroughly tested under hours of rigorous workflows and qualified by a number of groups to ensure the highest quality and performance.

CAT qualification includes:

- All hardware aspects relating to Thunder are tested (USB, video card, CPU, memory utilization and storage subsystem performance).
- Hours of Thunder functionality and workflow testing are performed in combination by QA and Systems Engineering. (e.g. capture, import, playback, dual display, PTT, output to file, network performance, etc.).
- All Qualification testing is performed on the Systems Engineering ghost image, which then becomes the tested/qualified shipping image containing required custom OS and component configuration settings to obtain maximum performance for Thunder.
- Qualified units are fully supported through CAT for both hardware and software. CAT will then maintain these systems in house for CS and Eng to troubleshoot any issue that may occur.

Note – CAT requires an English Language OS at this time on all Clients and Servers

CAT Server Summary

XOS Server Model	CPU	Memory GB	Mboard NIC	OS Windows Server	SQL Lic for Future Upgrades	OS SSD (GB) RAID-1	RAID Type	Media Drive (TB)	# of Media Drives	Raw Capacity (TB)	Aproximate Formated Capacity (TB)	PCI-e SSD for SQL DB	Remote Mgmt Console	DVD	Power Supply	Rack Units
MS-186-Combo	Dual Quad	64 std or 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	15	16	240.00	210.00	Yes	Yes	No	Dual - Redundant	3U
MS-182-Combo	Dual Quad	64 std or 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	11	16	176.00	154.00	Yes	Yes	No	Dual - Redundant	3U
MS-182-M	Dual Quad	32 std	Dual 10 Gb cu	2016	2016	500	RAID-6	11	16	176.00	154.00	No	Yes	No	Dual - Redundant	3U
MS-178	Dual Quad	64 std / 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	7.8	16	124.80	109.20	Yes	Yes	No	Dual - Redundant	3U
MS-168	Dual Quad	32	Dual 10 Gb cu	2016	2016	500	RAID-6	7.8	16	124.80	109.20	No	Yes	No	Dual - Redundant	4U
MS-176	Dual Quad	16	Dual 1 Gb cu	2012	2012	500	RAID-6	5.46	16	87.36	76.44	Yes	No	Yes	Redundant	3U
MS-166	Dual Quad	16	Dual 1 Gb cu	2012	2012	500	RAID-6	5.46	16	87.36	76.44	No	No	Yes	Redundant	4U
MS-86-Combo-8	Dual Quad	64 std or 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	15	8	120.00	90.00	Yes	Yes	No	Dual - Redundant	2U
MS-82-Combo-8	Dual Quad	64 std or 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	11	8	88.00	66.00	Yes	Yes	No	Dual - Redundant	2U
MS-82-M-8	Dual Quad	32 std	Dual 10 Gb cu	2016	2016	500	RAID-6	11	8	88.00	66.00	No	Yes	No	Dual - Redundant	2U
MS-82-Combo-6	Dual Quad	64 std or 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	11	6	66.00	44.00	Yes	Yes	No	Dual - Redundant	2U
MS-82-M-6	Dual Quad	32 std	Dual 10 Gb cu	2016	2016	500	RAID-6	11	6	66.00	44.00	Yes	Yes	No	Dual - Redundant	2U
MS-78	Dual Quad	64 std / 128 opt	Dual 10 Gb cu	2016	2016	500	RAID-6	7.8	6	46.80	31.20	Yes	Yes	No	Dual - Redundant	2U
MS-68	Dual Quad	32	Dual 10 Gb cu	2016	2016	500	RAID-6	7.8	6	46.80	31.20	No	Yes	No	Dual - Redundant	2U
MS-76	Dual Quad	16	Dual 1 Gb cu	2012	2012	500	RAID-6	5.46	6	32.76	21.84	Yes	No	Yes	Single	2U
MS-66	Dual Quad	16	Dual 1 Gb cu	2012	2012	500	RAID-6	5.46	6	32.76	21.84	No	No	Yes	Single	2U

Notes

- MS-86/186 Servers - Combo or Media Server
 - If a MS-86 or MS-186 is ordered to be used as a Combo Server then the following is added:
 - Memory - increased to 128GB standard
 - High performance PCIe SSD for Database
- SQL-2019 Lic Explanation
 - The SQL lic on CAT new servers will be SQL-2019 which allows them to run either SQL-2012 or SQL-2016.
 - Since Thunder is currently running SQL-2012 that is what will be installed in 2021.
 - However, when Thunder upgrades to SQL-2019 these customers will already have a SQL-2019 lic so not upgrade cost required...

CAT Hockey Travel Server Case

- CAT Travel Server Case Dimensions
 - External 42L x27W x32H
 - Internal 8 RU 30" depth
 - Model # 3SKB-R906U30

Networking

CAT Routers - Current

- (16) Port 1Gb Cisco RV345 Dual WAN Gigabit Layer-3 Router

CAT Switches - Current

- (24) Port 10Gb Cisco SX350X-24 Layer-2 Managed - (22) 10Gb copper & (2) SFP ports

1Gb	SR - MultiMode Fiber (MMF) 850nm	MGBSX1 SFP
1Gb	LR - Single Mode Fiber (MMF) 1310nm	MGBLH1 SFP
10Gb	SR - MultiMode Fiber (MMF) 850nm	SFP+
10Gb	LR - Single Mode Fiber (MMF) 1310nm	SFP+
- (24) Port 1Gb HP 2530-24G Layer-2 Managed Switch (24) 1Gb plus (4) SFP ports

HP J4859C	Single Mode Fiber (SMF)	LX SFP with 1310nm Laser – 1Gb
HP J4858C	Multi Mode Fiber (MMF)	SX SFP with 850nm Laser – 1Gb

Note – Fiber SFPs do not come with the switch and must be purchased separately based on needs...

- (8) Port 1Gb Dell PowerConnect 2808
- (16) Port 1Gb HP 1410/1420 Layer-2 Switch Used with CAT MicroServer

Ethernet Distance limitations:

- Maximum CAT-5E or CAT6 segment length is 100m (~330ft)
- Fiber links should be used if greater distance is required.

10 Gb Networking Notes

- 10Gb Copper Ethernet requires either CAT-6A or CAT-7 Ethernet Cables
- 10Gb NICs can operate at 1Gb or 10Gb
- 10Gb SFPs can only operate at 10Gb
- 1Gb Media Converter - Converts 1Gb copper Ethernet to 1Gb SMF/LR – LC connector

Networking Guidelines

- In order to support the full features of the CAT Thunder Network Based Video Workgroup solution, CAT requires that CAT clients be connected to CAT server(s) via a 1Gb pipe.
- While it might appear that based on payload size that a 100Mb link should be able to provide enough bandwidth for video, testing has demonstrated that a 100Mb link does not provide sufficient headroom or buffering to handle peak loads in mixed workflows.
- Utilizing a 1Gb network pipe from the CAT Server to the Client PC also eliminates the need for high performance network switches with a large amount of buffering. By keeping the entire network pipe at 1Gb this reduces and effectively eliminates the 1Gb to 100Mb “back pressure” on the switching infrastructure allowing better use of available buffering and more predictable application performance.
- To allow for maximum throughput and help in isolating issues to a particular segment, CAT recommends that if multiple network switches are utilized, they be connected in a Star configuration vs serially or cascaded.

Thunder Client Prerequisites

- CAT Requires
 - Win-10 x64 OS with English Language Support – Supported with Thunder
 - SQL-2012 with SP-4 (min) - Required
 - 16GB of RAM memory Recommended
- A 1 GB NIC with acceptable iPerf performance is required for video capture and playback on all Thunder clients
- A Dual Core Processor (not hyper threading) is recommended for all clients; on legacy single core processor clients service may need to disable deinterlacing to reduce the load on the system. Note: Disabling de-interlacing will reduce video quality.
- A qualified graphics card is required for all clients.

CAT Qualified Client Desktops:

HD Capable:

Current Shipping: *Will support EditStation & CoachingStation full workflow*

- o 3450 SFF

CAT Qualified Client Laptops:

HD Capable:

Current Shipping: *Will support EditStation & CoachingStation full workflow*

- o Dell 7560, 7550, 5420

Notes

- **16 GB minimum of Memory Recommended for all Windows-10 Systems**
- **CAT requires an English Language OS at this time**

Microsoft Surface Recommended Configuration

	Model	Display	CPU	Ram GB	SSD	Support	NIC
	Surface Pro 7+	12.3" 2160x1440	Core i7-1165G7	16	1TB	1-Yr Pro	USB-3 1Gb

- **Win-10 Professional (64-bit) (English)**
 - o SQL 2012 – 1 Cal – Required for Thunder, Not required for WUA

APPENDIX A: CAT Qualified Data Base Servers (detailed)

- **Combo Server 188-Combo (Intel S2600ST Sawtooth Pass) Storage: 324TB / 280TB formatted**
 - 3U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 5.25 in
 - Dual Redundant 800W supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 3.35, BTU/hr: ~1300
 - Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - 128GB RAM – (4 x 32GB) -
 - Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - Remote Management Console
 - (2) Micron 5300 960GB SSD OS drives (RAID-1)
 - (16) 18TB SATA drives configured as RAID-6
 - (1) LSI 9560-16i
 - Thunder SQL DB Performance Acceleration - Currently: Micron 9300 3.8TB SSD and U.2. to PCIe adapter
 - OS Support
 - Windows Server 2019 Standard (64-bit) Server license (English)
 - SQL 2019 License – 1 Cal
 - Symantec Antivirus with CAT exclusions
 - Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Combo Server 186-Combo (Intel S2600ST Sawtooth Pass) Storage: 240TB / 200TB formatted**
 - 3U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 5.25 in
 - Dual Redundant 800W supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 3.35, BTU/hr: ~1300
 - Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
 - Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - Remote Management Console
 - (2) 512GB SSD system drives (RAID-1)
 - (16) 16TB SATA drives configured as RAID-6
 - (1) LSI 9361-16i with 2GB cache
 - (1) 2.0TB Intel P-4600 PCIe SSD – for Thunder SQL DB
 - Thunder SQL DB Performance Acceleration - Currently: 800GB Intel P-3600 PCIe SSD
 - OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
 - Symantec Antivirus with CAT exclusions
 - Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Combo Server 182-Combo (Intel S2600ST Sawtooth Pass) Storage: 176TB / 154TB formatted**
 - 3U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 5.25 in
 - Dual Redundant 800W supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 3.35, BTU/hr: ~1300
 - Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
 - Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - Remote Management Console
 - (2) 512GB SSD system drives (RAID-1)
 - (16) 12TB SATA drives configured as RAID-6
 - (1) LSI 9361-16i with 2GB cache
 - (1) 2.0TB Intel P-4600 PCIe SSD – for Thunder SQL DB
 - Thunder SQL DB Performance Acceleration - Currently: 800GB Intel P-3600 PCIe SSD
 - OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
 - Symantec Antivirus with CAT exclusions

- o Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Combo Server 88-Combo (Intel S2600ST Sawtooth Pass) Storage: 144TB / 100TB formatted**
 - o 2U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 3.5 in
 - o Dual Redundant 800 watt supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 2, BTU/hr: ~785
 - o Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - o Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - o 128GB RAM – (4 x 32GB) -
 - o Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - o Remote Management Console
 - o (2) Micron 5300 960GB SSD OS drives (RAID-1)
 - o (8) 18TB SATA drives configured as RAID-6
 - o (1) LSI 9560-16i
 - o (1) 2.0TB Intel P-4600 PCIe SSD – for Thunder SQL DB
 - o Thunder SQL DB Performance Acceleration - Currently: Micron 9300 3.8TB SSD and U.2. to PCIe adapter
 - o OS Support
 - Windows Server 2019 Standard (64-bit) Server license (English)
 - SQL 2019 License – 1 Cal
 - o Symantec Antivirus with CAT exclusions
 - o Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Combo Server 86-Combo-8 (Intel S2600ST Sawtooth Pass) Storage: 120TB / 90TB formatted**
 - o 2U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 3.5 in
 - o Dual Redundant 800 watt supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 2, BTU/hr: ~785
 - o Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - o Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - o 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
 - o Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - o Remote Management Console
 - o (2) 512GB SSD system drives (RAID-1)
 - o (8) 16TB SATA Drives (RAID-6)
 - o (1) Avago (LSI) 9361 RAID Controller
 - o (1) 2.0TB Intel P-4600 PCIe SSD – for Thunder SQL DB
 - o OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
 - o Symantec Antivirus with CAT exclusions
 - o Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Combo Server 82-Combo-8 (Intel S2600ST Sawtooth Pass) Storage: 88TB / 66TB formatted**
 - o 2U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 3.5 in
 - o Dual Redundant 800 watt supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 2, BTU/hr: ~785
 - o Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - o Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - o 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
 - o Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - o Remote Management Console
 - o (2) 512GB SSD system drives (RAID-1)
 - o (8) 12TB SATA Drives (RAID-6)
 - o (1) Avago (LSI) 9361 RAID Controller
 - o (1) 2.0TB Intel P-4600 PCIe SSD – for Thunder SQL DB
 - o OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
 - o Symantec Antivirus with CAT exclusions
 - o Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Combo Server 82-Combo-6 (Intel S2600ST Sawtooth Pass) Storage: 66TB / 44TB formatted**

- o 2U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 3.5 in
- o Dual Redundant 800 watt supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 2, BTU/hr: ~785
- o Rail Size Min: ~28 in vs Max: 36 in (estimate)
- o Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
- o 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
- o Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
- o Remote Management Console
- o (2) 512GB SSD system drives (RAID-1)
- o (6) 12TB SATA Drives (RAID-6)
- o (1) Avago (LSI) 9361 RAID Controller
- o (1) 800GB Intel P-3600 PCIe SSD – for Thunder SQL DB
- o OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
- o Symantec Antivirus with CAT exclusions
- o Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Combo Server 82-Lite-6 (Intel S2600ST Sawtooth Pass) Storage: 46TB / 30TB formatted**
 - 2U Chassis - Chassis dimensions: (L x W x H) 26 in x 17 in x 3.5 in
 - Dual Redundant 800 watt supplies. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 2, BTU/hr: ~785
 - Rail Size Min: ~28 in vs Max: 36 in (estimate)
 - Dual Quad Core Intel Silver 4110 2.1 GHz / 3.0 GHz Turbo Processors
 - 64GB RAM – (4 x 16GB) - Ability to upgrade to 128 GB Memory possible
 - Intel Dual Port 10 Gigabit NICs – Copper – Requires CAT-6A or CAT-7 Cables for 10Gb
 - Remote Management Console
 - (2) 512GB SSD system drives (RAID-1)
 - (6) 8TB SATA Drives (RAID-6)
 - (1) Avago (LSI) 9361 RAID Controller
 - OS Support
 - Windows Server 2016 Standard (64-bit) Server license (English)
 - SQL 2016 License – 1 Cal
 - Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Dell 7560 Thunder NHL Micorserver**
 - 11th Gen Intel Core Processor i9-11950H (8 Core, 24MB Cache, 2.60GHz to 5.00GHz, 45W, vPro)
 - 128 GB, 4 x 32 GB, DDR4, 3200MHz, Non-ECC, SODIMM
 - Hard Drive 1: M.2 2280 2 TB, Gen 4 PCIe x4 NVMe, Solid State Drive
 - Hard Drive 2: Additional M.2 2280 2 TB, Gen 4 PCIe x4 NVMe, Solid State Drive
 - NVIDIA RTX A2000 w/4 GB GDDR6
 - 15.6" FHD, 1920x1080, 60Hz, Anti-Glare, Non-Touch, 100% DCIP3, 500 Nits, Cam/Mic, WWAN/WLAN capable
 - Intel Wi-Fi 6E AX210 Wireless Card with Bluetooth 5.2
 - Intel gigabit Network connection
 - 6 Cell 95Whr ExpressCharge Capable Battery
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Dell 7550 – Thunder Hockey/Basketball/Football MicroServer**
 - Intel i7- 7820HQ 2.9 GHz (4 cpus 8MB cache)
 - 32GB Ram (2400MHz DDR4 Non-ECC SDRAM)
 - Storage
 - Drive-1: OS & Applications
 - 512GB PCIe SSD – Standard
 - Drive-2: Database
 - 512GB SATA SSD - Standard
 - 1TB SATA SSD – Optional
 - 16TB USB-3 RAID-1 Subsystem (2) 8TB SATA drives) – Near line Media
 - nVidia Quadro M1200 w/4GB GDDR5
 - Intel HD Graphics 630
 - 15.6" UltraSharp FHD IPS(1920x1080) Panel 300nits Brightness
 - Intel gigabit Network connection
 - Intel WiFi Link 8265 2x2 802.11ac
 - 6-cell (91WH) Lithium Ion Battery
 - Legacy Dell Docking Station
 - Integrated webcam
 - Display Port 1.2
 - Biometric fingerprint reader
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - Custom OS and component configuration settings to obtain maximum performance for Thunder

- **Dell 7550 – Thunder Baseball MicroServer / Travel Laptop**
 - Intel i7- 7820HQ 2.9 GHz (4 cpus 8MB cache)
 - 32GB Ram (2400MHz DDR4 Non-ECC SDRAM)
 - Storage
 - Drive-1: OS & Applications
 - 512GB PCIe SSD – Standard
 - Drive-2: Database and Online media
 - 1 TB SATA SSD – Standard
 - 16TB USB-3 RAID-1 Subsystem (2) 8TB SATA drives) – Near line Media
 - nVidia Quadro M1200 w/4GB GDDR5
 - Intel HD Graphics 630
 - 15.6" UltraSharp FHD IPS(1920x1080) Panel 300nits Brightness
 - Intel gigabit Network connection
 - Intel WiFi Link 8265 2x2 802.11ac
 - 6-cell (91WH) Lithium Ion Battery
 - Legacy Dell Docking Station
 - Integrated webcam
 - Display Port 1.2
 - Biometric fingerprint reader
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - Symantec Antivirus with CAT exclusions
 - Custom OS and component configuration settings to obtain maximum performance for Thunder
 - **Optional Docking Station**
 - **Dell E-Port Replicator Dock & Spacer**

APPENDIX B: CAT Qualified Client Desktops

- **Dell 3450 Small Form Factor– Thunder HD** Width 3.7" Depth 11.4" Height 11.5" Weight 11.5 lbs
 - Intel® Core™ i9-11900 (8 Core, 16MB cache, up to 5.2GHz)
 - 32GB, 2x16GB, DDR4 UDIMM non-ECC Memory
 - NVIDIA T600 4GB LP (4 mDP to DP adapters)
 - (4) miniDisplay Ports
 - Intel 1Gb NIC PCIe Card (Low Profile)
 - Intel® Wi-Fi 6 AX201 802.11ax Dual Band (2x2) Wireless Module + Bluetooth 5, w/Internal Antenna
 - 512GB PCIe NVMe Class 40 M.2 SSD
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - (1) Display Port to Female DVI Adapter
 - (1) Display Port to HDMI Adapter – 4K

- **Dell 3440 Small Form Factor– Thunder HD** - Width 3.7" Depth 11.4" Height 11.5" Weight 11.5 lbs
 - Intel Core i9-10900, 10 Core, 20MB Cache, 2.8GHz, 5.2GHz
 - 32GB 2x16GB DDR4 2666MHz UDIMM Non-ECC Memory
 - Intel 630 Graphics
 - (2) Full Size Display Ports
 - Integrated Gigabit Ethernet controller
 - Intel Wireless 6 AX201, Dual-band 2x2 802.11ax Wi-Fi and Bluetooth 5
 - (1) 512GB PCIe NVMe Class 40 Solid State Drive
 - OS
 - Win-10 Professional (64-bit) (English)
 - Custom OS and component configuration settings to obtain maximum performance for Thunder
 - (1) Display Port to Female DVI Adapter
 - (1) Display Port to HDMI Adapter – 4K

APPENDIX C: CAT Qualified Client Laptops (detailed)

- **Dell 7320 Tablet– Thunder HD - Approx weight 6.0 lbs – with 180 Watt PS**
 - 11th Generation Intel® Core™ Processors up to i7 vPro
 - Up to 16GB LPDDR4X SDRAM 4267MHz (on board)
 - SSD-M.2-2230-1TB-PCIe/NVMe Class 35
 - Intel® Iris® Xe integrated Graphics
 - 13.0" 3:2 FHD+ (1920 x 1280) Touch, 500 nits Super Low Power and ComfortView Plus - Low Blue Light; Corning® Gorilla™ Glass DX Touch;Active Pen Support
 - Intel® Dual Band Wireless Intel Wi-Fi 6 AX201 2x2ax (Harrison Peak2) CNVi + Bluetooth 5.1
 - Dell Thunderbolt™ Dock- WD19TB
 - 2-Cell, 40 WH6 Polymer , ExpressCharge 2.0™,ExpressCharge Boost™ & Long Life Cycle capable
 - 65W adapter, USB Type-C
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - SQL 2019 - 1 Cal
 - Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Dell 7560 – Thunder HD & OpenField Capable - Approx weight 6.0 lbs – with 180 Watt PS**
 - **Standard Configuration options**
 - **1TB with 32GB RAM**
 - **2TB with 32GB RAM**
 - **4TB with 128GB RAM**
 - 11th Gen Intel Core Processor i9-11950H (8 Core, 24MB Cache, 2.60GHz to 5.00GHz, 45W, vPro)
 - 128 GB, 4 x 32 GB, DDR4, 3200MHz, Non-ECC, SODIMM; 32 GB, 2 x 16 GB, DDR4, 3200MHz, Non-ECC, SODIMM
 - Hard Drive 1: M.2 2280 2 TB, Gen 4 PCIe x4 NVMe, Solid State Drive: M.2 2280 1 TB, Gen 3 PCIe x4 NVMe, Solid State Drive
 - Hard Drive 2:Additional M.2 2280 2 TB, Gen 4 PCIe x4 NVMe, Solid State Drive
 - NVIDIA RTX A2000 w/4 GB GDDR6
 - 15.6" FHD, 1920x1080, 60Hz, Anti-Glare, Non-Touch, 100% DCIP3, 500 Nits, Cam/Mic, WWAN/ WLAN capable
 - Intel Wi-Fi 6E AX210 Wireless Card with Bluetooth 5.2
 - Intel gigabit Network connection
 - 6 Cell 95Whr ExpressCharge Capable Battery
 - OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2012 – 1 Cal
 - Custom OS and component configuration settings to obtain maximum performance for Thunder
- **Dell 7550 Performance Model – Thunder HD & OpenField Capable - Approx weight 6.0 lbs – with 180 Watt PS**
 - Intel Core Processor i7-10750H (6 Core, 12MB Cache, 2.60 GHz to 5.00 GHz, 45W)
 - 32GB, 2X16GB, DDR4 2933Mhz Non-ECC Memory
 - Storage
 - Drive-1: OS & Applications
 - 1TB or 2TB PCIe NVMe Class-40 drive
 - Drive-2: Media or Data - Optional
 - **TBD** PCIe NVMe Class-40 drive
 - NVIDIA Quadro T1000 w/4GB GDDR6
 - Intel UHD Graphics
 - 15.6" FHD, 1920x1080, 60Hz, Anti-Glare, Non-Touch, 100% DCIP3, 500 Nits
 - Intel gigabit Network connection
 - Intel Wi-Fi 6 AX201 Wireless
 - 6-cell 95WH Lithium Ion battery with ExpressCharge™
 - Integrated webcam
 - (1) Mini Display Port, (1) HDMI Port, (2) USB Ports; (2) USB Type-C Thunderbolt Ports
 - Biometric fingerprint reader
 - OS

- Win-10 Professional (64-bit) (English)
 - SQL 2016 Embedded Runtime License – 1 Cal
 - o Custom OS and component configuration settings to obtain maximum performance
 - o **Optional Docking Station & Cables**
 - **Precision Dual USB-C Thunderbolt Dock – WD19TB – Includes 180 Watt PS**
 - (1) Display Port to Female DVI Adapter – CAT # 6013
 - (1) HDMI to Female DVI Adapter – CAT # 5778
- **Dell 7550 Value Model – Thunder HD Capable - Aprox weight 6.0 lbs – with 180 Watt PS**
 - o Intel Core Processor i7-10750H (6 Core, 12MB Cache, 2.60 GHz to 5.00 GHz, 45W)
 - o 16GB, 2X8GB, DDR4 2933Mhz Non-ECC Memory
 - o Storage
 - Drive-1: OS & Applications
 - 512GB PCIe NVMe Class-40 drive - Optional
 - o NVIDIA Quadro T1000 w/4GB GDDR6
 - o Intel UHD Graphics
 - o 15.6" FHD, 1920x1080, 60Hz, Anti-Glare, Non-Touch, 100% DCIP3, 500 Nits
 - o Intel gigabit Network connection
 - o Intel Wi-Fi 6 AX201 Wireless
 - o 6-cell 95WH Lithium Ion battery with ExpressCharge™
 - o Integrated webcam
 - o (1) Mini Display Port, (1) HDMI Port, (2) USB Ports; (2) USB Type-C Thunderbolt Ports
 - o OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2016 Embedded Runtime License – 1 Cal
 - o Custom OS and component configuration settings to obtain maximum performance
 - o **Optional Docking Station & Cables**
 - **Precision Dual USB-C Thunderbolt Dock – WD19TB – Includes 180 Watt PS**
 - (1) Display Port to Female DVI Adapter – CAT # 6013
 - (1) HDMI to Female DVI Adapter – CAT # 5778
- **Dell Latitude 5420 – Thunder HD Capable**
 - o Approx. weight 3.1 lbs.
 - o **Standard Configuration options**
 - 1TB 16GB RAM
 - 2TB 16GB RAM
 - o 90W E5 Type-C Power Adapter
 - o 11th Generation Intel Core i7-1185G7 (4 Core, 12M cache, base 3.0GHz, up to 4.8GHz, vPro)
 - o 16GB, 1 x 16GB, DDR4 Non-ECC
 - o 1TB or 2TB PCIe NVMe Class 40 Solid State Drive
 - o Intel Xe Graphics
 - o 14" FHD (1920x1080) Touch, Anti-Glare, IPS, 300nits
 - o Network connection – RJ45
 - o Intel Wi-Fi 6 AX201 2x2 .11ax 160MHz + Bluetooth 5.1
 - o (1) HDMI Port, (2) USB Ports; (2) USB Type-C Thunderbolt Ports
 - o 4 Cell 63Whr ExpressCharge™ Capable Battery
 - o Integrated webcam
 - o Biometric fingerprint reader
 - o OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2016 – 1 Cal

- o Custom OS and component configuration settings to obtain maximum performance for Thunder
- o **Optional WD19TB USB Type C Docking Station with Display Port v1.2**
 - Provides:
 - (2) Full Size Display Ports
 - (1) HDMI Port
 - Refer to Dell Spec for full details

Note - Requires Full Size Display Port to Female DVI Adapter for CAT Monitor – CAT # 6010

- **Dell 5410 Performance Model – Thunder HD Capable**

- o Approx weight 3.0 lbs
- o 65 Watt Universal Power Supply
- o Intel® Core™ i7-10610U (4 Core, 8M cache, base 1.8GHz, up to 4.9GHz, vPro)
- o 16GB, 2x8GB, DDR4 Non-ECC
- o 1TB or 2TB PCIe NVMe Class 40 Solid State Drive
- o Intel UHD Graphics
- o 14.0" FHD (1920 x 1080) 220 Nit Anti-Glare Touchscreen - 220 nits Brightness
- o Network connection – RJ45
- o Intel Dual Band Wi-Fi 6 AX201 2x2 802.11ax 160MHz + Bluetooth 5.1
- o (1) Mini Display Port, (1) HDMI Port, (3) USB Ports; (1) USB Type-C Thunderbolt Ports
- o Lithium Ion 4 Cell 68Whr ExpressCharge Capable Battery
- o Integrated webcam
- o Biometric fingerprint reader
- o OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2016 – 1 Cal
- o Custom OS and component configuration settings to obtain maximum performance for Thunder

- o **Optional WD19TB USB Type C Docking Station with Display Port v1.2**

- Provides:
 - (2) Full Size Display Ports
 - (1) HDMI Port
- Refer to Dell Spec for full details

Note - Requires Full Size Display Port to Female DVI Adapter for CAT Monitor – CAT # 6010

- **Dell 5410 Value Model – Thunder HD Capable**

- o Aprox weight 3.0 lbs
- o 65 Watt Universal Power Supply
- o Intel® Core™ i7-10610U (4 Core, 8M cache, base 1.8GHz, up to 4.9GHz, vPro)
- o 16GB, 2x8GB, DDR4 Non-ECC
- o 512GB PCIe NVMe Class 40 Solid State Drive
- o Intel UHD Graphics
- o 14.0" FHD (1920 x 1080) 220 Nit Anti-Glare 220 nits Brightness
- o Network connection – RJ45
- o Intel Dual Band Wi-Fi 6 AX201 2x2 802.11ax 160MHz + Bluetooth 5.1
- o (1) Mini Display Port, (1) HDMI Port, (3) USB Ports; (1) USB Type-C Thunderbolt Ports
- o Lithium Ion 4 Cell 68Whr ExpressCharge Capable Battery
- o Integrated webcam
- o OS
 - Win-10 Professional (64-bit) (English)
 - SQL 2016 – 1 Cal
- o Custom OS and component configuration settings to obtain maximum performance for Thunder

- o **Optional WD19TB USB Type C Docking Station with Display Port v1.2**

- Provides:
 - (2) Full Size Display Ports
 - (1) HDMI Port
- Refer to Dell Spec for full details

Note - Requires Full Size Display Port to Female DVI Adapter for CAT Monitor – CAT # 6010

APPENDIX E: CAT Qualified Transcode Servers (Detailed)

- **TC-10 – Transcode Server**

- o 1U Chassis - Chassis dimensions: (L x W x H) 13 in x 17 in x 1.7 in
- o Power: (1) 200W pwr supply. Voltage: 110-240 vac 50/60 Hz, Typical Amps: 1, BTU/hr: ~350
- o Quad Core Intel i7 4770S 3.1GHz Cpu
- o 8GB (2x4GB) 1600 MHz DIMM
- o Intel 4600 Graphics
- o Integrated Gigabit Ethernet controller
- o (1) 512GB SSD drive
- o OS
 - Win-10 Professional (64-bit) (English)
- o Symantec Antivirus with CAT exclusions
- o Custom OS and component configuration settings to obtain maximum performance

APPENDIX F: Media Type vs Storage Usage Table

Media Type	Codec	Media Mb/s	Media MB/s	Approximate MB Per Hour	Approximate Hours per TB	GB for 50 Hours	GB for 100 Hours
DV25 (25 Mb)	DV-25	25	3.13	11,250	98	563	1,125
SD 480i (1.5 Mb)	H-264	1.5	0.19	675	1,629	34	68
SD 480i (3 Mb)	H-264	3	0.38	1,350	814	68	135
HD 720p (3 Mb)	H-264	3	0.38	1,350	814	68	135
HD 720p (6 Mb)	H-264	6	0.75	2,700	407	135	270
HD 720p (8 Mb)	H-264	8	1.00	3,600	305	180	360
HD 1080i (3 Mb)	H-264	3	0.38	1,350	814	68	135
HD 1080i (6 Mb)	H-264	6	0.75	2,700	407	135	270
HD 1080i (8 Mb)	H-264	8	1.00	3,600	305	180	360
HD 1080p (5 Mb)	H-264	5	0.63	2,250	489	113	225
HD 1080p (10 Mb)	H-264	10	1.25	4,500	244	225	450
HD 1080p (12 Mb)	H-264	12	1.50	5,400	204	270	540
High HD WMV	Windows Media	3	0.38	1,350	814	68	135
Medium HD WMV	Windows Media	2	0.25	900	1,222	45	90
Low HD WMV	Windows Media	1.5	0.19	675	1,629	34	68
MPEG-2	MPEG-2	9	1.13	4,050	271	203	405
Constants	Value						
1.0 TB	1,099,511,627,776						

APPENDIX G: Thunder Hockey HD Video Spec

Thunder Hockey 2020 using the Black Magic USB Pro Capture Device can support/capture video and audio from the following feed types:

HD-SDI

- Connection: HD-SDI cable with BNC connector
- 720p video (59.94)
- Embedded audio on SDI channel 1+2 as a stereo pair

Component with Line Audio

- 720p video (59.94) via (3) component inputs with BNC connectors
- Line Audio as a stereo pair from male RCA connectors
- Recommend using CAT audio converter with level display and adjustment to go from line to balanced audio

HDMI

- 720p video (59.94)
- Audio
- Can be used for input from a video camera but not from cable box or Satellite...

Notes

- CAT offers a SDI Up/Down converter that may be used to convert:
 - HD-SDI 1080i (59.94) to HD-SDI 720P (59.94)
 - SDI SD NTSC to HD-SDI 720P (59.94)
- The standard Canopus 1394 converter can be used with NTSC S-Video or Composite

APPENDIX H: CAT Baseball IP Cameras

We have successfully verified the following IP Cameras with CAT Baseball

- Marshall VS-547
- Axis PTZ P5624-E Mk II 720p@60
- Axis PTZ Q6114-E 720p@60.
- Axis PTZ Q6124-E 720p@60.

APPENDIX I: CAT Video Camera Verification List

Camera Vendor	Model	Thunder Compatible	XOS Verified	Live 1080P	Live 1080i	Live 720p	Live Audio	HDMI 4.5 FT Max	HD-SDI 300FT Max	AVCHD Import	MP4 Import	SDCard Size & File System	Comments
Canon	XA 25	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	TBD	- In production - AVCHD import does not show thumbnail preview (camera limitation)
Canon	XA 35	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	- Standard SD - FAT32	- In production
Canon	XF 105	Yes V+A	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	CANNOT record video to SDCard Must use CF Card	- In production - Red Flags: No AVCHD. Cannot record video to SD Card. Records MP ES2 not MP4
Canon	XF 205	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	TBD	- In production
GoPro	Hero 4- Black	Yes V+A	Yes	No	No	No	No	Yes	No	No	Yes	- MicroSD - XFAT/FAT32	- In production - Imported video (720 and 1080) must be trans coded as bitrates are higher than Thunder standards - Recommend users perform test captures to determine preferred FOV - Field of Vision (Wide, Medium, Narrow)
GoPro	Hero 4- Silver	Yes V+A	Yes	No	No	No	No	Yes	No	No	Yes	- MicroSD - XFAT/FAT32	- In production - Imported video (720 and 1080) must be trans coded as bitrates are higher than Thunder standards - Recommend users perform test captures to determine preferred FOV - Field of Vision (Wide, Medium, Narrow)
JVC	GY-HM506 C	Yes V+A	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	- Standard SD - FAT32	- In production - Supports GPS sync for Catapult Import
Panasonic	V 550	Yes V-Only	Yes	Yes	No	No	Yes	Yes	No	TBD	TBD	TBD	- In production
Sony	HDR-CX 190	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	- Standard SD - FAT32	- No longer in production- AVCHD import - recommend "Standard" image quality setting as Highest/High will require trans code due to high bitrate
Sony	HDR-CX 220	Yes V-Only	Yes	Yes	No	Yes	No	Yes	No	TBD	TBD	- Standard SD - XFAT/FAT32	- No longer in production
Sony	HDR-CX 240	Yes V-Only	Yes	Yes	No	Yes	No	Yes	No	TBD	TBD	TBD	- In production
Sony	HDR-CX 440	Yes V-Only	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	TBD	- In production - recommend "Standard" image quality setting as Highest/High will require trans code due to high bitrate
Sony	NXCAM 5	Yes V+A	Customer OK	No	Yes	Yes	Yes	Yes	Yes	TBD	TBD	TBD	- In production
Sony	PXW-X70	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	- Standard SD - FAT32	- In production - recommend HQ image quality setting for 1080i/720p AVCHD import - other formats must be trans coded on import due to high bitrate - 1080p AVCHD cannot be imported
Sony	HDR-NX100	Yes V+A	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	- Standard SD - FAT32	- In production - No live HD-SDI output, HDMI only - recommend HQ image quality setting for 1080i/720p AVCHD import - other formats must be trans coded on import due to high bitrate - 1080p AVCHD cannot be imported

VIDEO MODE	MINUTES / 64GB	MINUTES / 32GB	MINUTES / 4GB
			File size limitation cut-off
1080p 60fps	262	131	16.4
1080p 60fps + Protune	176	88	11.0
1080p 60fps Superview	262	131	16.4
1080p 60fps Superview +	176	88	11.0
720p 60fps	262	131	16.4
720p 60fps + Protune	176	88	11.0
720p 60fps Superview	262	131	16.4
720p 60fps Superview +	176	88	11.0
720p 30fps	353	176.5	22.1