2022 UNIDATA COMMUNITY EQUIPMENT AWARD PROPOSAL

Deploying a JupyterHub Server to Support Education and Research at ULM

Date: 25 March 2022

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1. PROJECT SUMMARY

This proposal requests funds to purchase computing hardware to deploy a JupyterHub server to increase the use of Python within the University of Louisiana at Monroe's (ULM) broader geoscience curriculum and research. The server would allow for significant enhancements to the current curriculum while also supporting future curriculum changes that place a larger emphasis on scientific computing. This will ensure we can continue to train students from diverse backgrounds who are well-prepared for the STEM workforce and/or graduate degree programs. The server would be incorporated into ULM's overall Information Technology (IT) infrastructure, but would be dedicated for use by faculty and students in the Atmospheric Science (ATMS) program. Acquisition of the server would represent a large technology upgrade for the program, helping to ensure greater equity in access to the hardware and software necessary for scientific computing-related teaching and research tasks. We plan to document any lessons learned while deploying the JupyterHub server to assist others who may embark on a similar process.

2. PROJECT DESCRIPTION

a. Background and Goals

ULM is a doorway to diverse academic studies for residents of northeast Louisiana and the Lower Mississippi Delta region, historically an economically disadvantaged area. Enrollment for the Fall 2021 semester was 8,565 students, which includes students from every parish in Louisiana, 47 other states, and 48 foreign countries. The ATMS program within the School of Sciences (SOS) offers the *only* B.S. degree in atmospheric science or meteorology in Louisiana, with a curriculum that meets guidelines established by the American Meteorological Society and federal government (GS-1340). The program typically has 40-60 majors, *many first-generation college students or students from disadvantaged socio-economic groups*, and is continually recognized as a *Program of Excellence* by the University of Louisiana Board of Supervisors. The ATMS program has four faculty members and its own teaching and research facilities like the Weather Research Center (WRC), Synoptic Meteorology Lab (SML), and Geosciences Computer Lab (GCL). A combination of internal and external funding has facilitated significant improvements in recent years to the program's teaching and research infrastructure, including the acquisition of a polarimetric S-band Doppler weather radar, mobile radiosonde systems, a microwave radiometer, a Doppler wind lidar, various surface measurement systems, and a truck for mobile data collection. This unique collection of instrumentation has supported a robust externally funded research program enabling experiential teaching and research opportunities for numerous undergraduate students. Additionally, a 2016 Unidata Equipment Award provided hardware to update the computing infrastructure in the SML, including a dedicated AWIPS-II (EDEX) data server. ULM continues to invest in our program, recently approving a new faculty line in the area of Earth System Science (ESS) to start next Fall semester. This, along with a recent new hire in Geography (co-I Fricker), will enable development of a new concentration in ESS within the broader undergraduate ATMS degree program.

The ULM ATMS program is unique in that it is the *only* program in Louisiana and Arkansas and one of only a few programs across the United States that exclusively educates undergraduates. ULM is an active participant in University Corporation for Atmospheric Research (UCAR)

activities, particularly those pertaining to undergraduate education, and became a full UCAR voting member in 2013 after serving as an academic affiliate member for several years. The ATMS program is also an active participant in the Unidata community and an active user of Unidata programs and data (e.g., IDV, AWIPS, MetPy) in both teaching and research. The 2016 Unidata Equipment Award allowed us to further increase participation in Unidata by deploying AWIPS-II and an EDEX data server for use in our weather analysis courses and improving computing hardware in our SML to better use other Unidata products. This was an important addition to our curriculum since a majority of our students pursue post-graduate employment with the National Weather Service (NWS). Having AWIPS-II available in the classroom enabled the creation of a new course, *Operational Decision Support Services*, that is actually led and co-taught by meteorologists from NWS Shreveport and NWS Jackson.

The ATMS curriculum is currently biased towards operational meteorology, where both theoretical and applied coursework are emphasized. Students receive scientific computing instruction utilizing Unidata programs or other advanced scientific programming through several courses, including a dedicated computer applications course for atmospheric science majors. Many students also gain programming experience through research opportunities provided by both internal and external sources. However, a major shift has occurred over the past several years where more and more of our students are finding post-graduate employment within the broader Earth System Science or Environmental Science sector, where programming and/or scientific computing skillsets are desired. In addition, more of our students are interested in continuing their education in graduate school, where programming and data science experience is also sought after.

To keep up with industry demands and to ensure our students are well-prepared for the changing earth science workforce, we have embarked on an ambitious plan to revamp our degree program over the next several years through three avenues: (1) adding a concentration in ESS that has a heavy focus on data science, (2) incorporating additional programming and data science-themed instruction in current ATMS courses, and (3) introducing new courses in these areas. Any new data science or programming-themed course would overlap concentrations within the ATMS program. As mentioned above, ULM has already approved a new faculty line to support the ESS concentration. We were also recently awarded a state grant providing funds to install several high-performance Apple workstations in the GCL to help transition to greater data science initiatives within the curriculum.

However, as we started planning for the increased programming-based curriculum and continue dealing with the effects of the COVID-19 pandemic, the inequities of deploying programming initiatives became immediately apparent. Current university protocol only allows student access to the ATMS computer labs at specific times during the week (7:30 a.m. – 9:00 p.m. on weekdays). This is an on-going issue in the computer applications course we offer, which currently focuses on programming using Interactive Data Language (IDL). Python environments could theoretically be established on student's personal computers since it is free and most packages are open-source, but the ULM student demographics means not all of our students have personal computers. If they do, the hardware is not likely sufficient to process large datasets. Faculty also would likely be tasked with assisting in the setup of multiple Python environments on student's personal computers. And all of this doesn't account for the possibility of offering

virtual course work or needing to pivot face-to-face instruction to a virtual format. *Deploying a JupyterHub server with external access to Jupyter Notebooks via a web browser would address many of these issues and inequities of our current hardware/software arrangement.* Students and faculty would have access to the necessary hardware and software from anywhere with an Internet connection to develop and run Python programs for teaching and research. We see the acquisition of a JupyterHub server as ***vital*** step in our plan to revamp the curriculum and to address student inequities.

b. Equipment Request

We request funds to purchase computing hardware that would support a JupyterHub server. The configuration of the server is based on recommendations by Kevin Goebbert (Valparaiso University), Unidata, and presentations given by Kevin Tyle (University of Albany) who has deployed a JupyterHub server in their program. We also used information provided from The Littlest JupyterHub documentation page for estimating memory, CPU needs, and disk space, all of which are based on the number of concurrent users. Discussions with Kevin Goebbert and recommendations by Kevin Tyle are to maximize the amount of RAM available (well above the minimum requirements suggested by The Littlest JupyterHub) since large geoscience datasets will quickly take up any available RAM. Initially the server would have up to 25 concurrent users at any one time. However, we expect there to be program growth, especially on the ESS side, which may double the number of concurrent users. The server was also quoted with specifications to future-proof against the growing size of geoscience datasets. Below is the hardware request with the primary specifications itemized. A full itemized list of the server specifications is provided with the quote at the end of this proposal.

Dell Precision 7920 Server Rack (JupyterHub Server)
Dual Intel Xeon Gold 6238R 2.2 GHz (4.0 GHz Turbo, 28 Cores) [56 total cores]
384GB 12x32GB DDR4 Memory
Mirrored M.2 512GB PCIe SSD Drives (Boot Drive)
Mirrored 2.5 1.92TB SATA SSD Drives (Data Storage Drives)

c. Available Resources and IT Support

The ATMS program maintains three primary lab spaces with computing facilities spread throughout. The WRC has six Windows-based workstations dedicated for student use, plus two workstations that serve as data logging systems for various instruments installed on campus. A digital map wall was installed four years ago and two additional workstations (one Windows and one Linux) are used to serve images to the map wall screens. The SML is our primary teaching lab with five dual-boot Linux/Windows workstations (acquired through a 2016 Unidata Equipment Award), four Apple workstations, and four additional Linux workstations available for teaching and research purposes. A high-performance modeling cluster with the Weather Research and Forecasting (WRF) model installed is available in the SML for teaching and research. A regional WRF simulation is run once a day with output available on our web-server. Finally, the open access GCL has 20+ Windows-based workstations. As previously mentioned, several high-performance Apple workstations will soon be installed in the GCL in support of incorporating more data science across the curriculum. The ATMS program and the SOS

maintains licenses to Matlab, IDL, ENVI, and ArcGIS. Python environments are also installed locally on most workstations in the SML and GCL. Two ATMS dedicated servers are currently installed and operational within ULM's primary server room: the EDEX data server which serves Unidata products to the workstations in the SML and a server that processes and stores data from the program's operational instruments. Live data from some of these instruments are generated from open-source Python libraries, such as PyART and Unidata's MetPy, and made available via the web (http://wxdata.geos.ulm.edu/).

Primary system management for all computing hardware on campus are handled by ULM's IT personnel. Given the unique computing requirements of the ATMS program, ATMS faculty and IT personnel work very closely together to plan technology upgrades and maintenance of the ATMS computing facilities. A strong partnership has developed over the years between the program and IT department, facilitated partly by one of the system administrators who is a graduate of the ATMS program. ATMS faculty members with expertise in Linux serve as secondary system managers for computing hardware in the program. Funds for technology upgrades are provided by both internal (e.g., regular technology improvement grants) and external (e.g., research and technology grants, indirect cost return) sources.

Administrating and maintaining the proposed JupyterHub server would be no different than our current approach. IT personnel will install the server in ULM's primary server room, alongside existing ATMS hardware, thereby fully integrating it into the overall IT infrastructure of the university. PI Murphy worked closely with IT personnel to configure the server to meet both the program's needs and to ensure it will install seamlessly with current hardware. ULM IT personnel will work with the PIs to install and configure The Littlest JupyterHub distribution (https://tljh.jupyter.org/en/latest/), while also making the server accessible outside the campus Intranet via an external web address (e.g., python.geos.ulm.edu). The PIs will be responsible for configuration and maintenance of Python environments and JupyterHub user accounts. IT support is affirmed by the approved ULM IT technology request document attached at the end of this proposal.

d. Benefits to Education & Research at ULM

Curriculum Benefits

Numerous education and professional benefits will be gained by deploying the JupyterHub server and expanding programming and data science-related topics across the curriculum. These initiatives will ensure the ULM ATMS curriculum stays relevant as scientific computing and data analytics skillsets become more desirable across the Earth science industry. Currently, the only course dedicated in the curriculum to scientific computing and programming is ATMS 3000 (*Computer Applications in Atmospheric Science*). Here, IDL has traditionally been used as the programming language of choice. The JupyterHub server would facilitate a transition to Python as the main language taught in this course. Basic Python programs have been utilized in other courses to show simple data analysis and visualizations (e.g., radar data, Skew-T diagrams, surface data time series), though no formal instruction is given. Students are also required to take CSCI 2000 (*Introduction to Programming*), which covers a range of topics in Python, Java, and C++.

Through our curriculum changes, we plan to not only expand the use of Python-based analysis and data visualization into other courses, but also introduce programming and data science much earlier in student's academic careers. One proposed plan is to remove the CSCI 2000 requirement and instead offer a series of 1-2 credit hour courses at the freshman and sophomore level within the program that introduces scientific computing, Python programming basics, and a more intermediate Python programming course. Offering these courses at the freshman to sophomore level will allow us to deploy additional simple programming exercises across other courses with confidence that students have the prerequisite knowledge. This would also enable ATMS 3000 to be revamped into a more advanced computer applications course, where intermediate to advanced data analytics and visualization topics can be addressed. Other courses where the JupyterHub server would see immediate use include but are not limited to:

- *ATMS 4006 – Radar Meteorology:* PyArt is utilized in this course to analyze and display radar data for semester projects. Python Jupyter Notebooks are in development to facilitate complete lessons on using PyArt for other tasks, such as rainfall estimation, de-aliasing radial velocity data, and attenuation correction.
- *ATMS 4020 – Numerical Modeling of the Atmosphere:* Python Jupyter Notebooks have already been developed for use in this course to analyze and visualize numerical model output.
- *GEOS 4035/4045 – Principles of GIS/Advanced GIS:* Python Jupyter Notebooks are in development to explore the value of Python window and an Integrated Development Environment (IDE) within ArcGIS and scripts within QGIS. Laboratory exercises are also in development to provide examples of the utility of Python coding within a larger geographic information systems environment.
- *GEOS 4050 – Remote Sensing of the Environment*: Python Jupyter Notebooks have been developed for use in this course to analyze changes in surface environments using Google Earth Engine imagery and the geemap package.

Other data science-themed courses are planned in conjunction with development of the ESS concentration that would utilize the JupyterHub server. For example, a quantitative methods in ESS course is being developed that will cover Python statistical methods and its utility in applied research within a broader ESS theme. The course will leverage Python Jupyter Notebooks as the source of lecture material, with problem sets and laboratory exercises to be completed in student-led Python Jupyter Notebooks.

The JupyterHub server will be leveraged across the ATMS curriculum to provide students with a necessary and important skillset to better prepare them for the future. The server would enable curriculum changes by providing the hardware necessary to support many concurrent users either on campus or off-campus and removing inequities associated with undergraduate high-performance computing access.

Research Benefits

As mentioned above, the unique set of instrumentation and expertise of ULM faculty have supported a robust externally funded research program. Faculty and students in the ATMS program are focused on a wide range of topics including radar and satellite meteorology, severe convective storms, precipitation processes, tropical meteorology, applied climatology, and

human-environment interaction. Participating in field work, observational case studies using our integrated set of instrumentation, and numerical simulations comprise most of the research conducted in the program. Undergraduate ATMS students have played a major role in the success of our research; students are often hired as research assistants or volunteer their time to work on research projects. Data processing and visualization are primarily completed using scientific programming languages such as Python. The JupyterHub server would play a major role in data processing and visualization of our research moving forward. The server will enable faster processing of extremely large datasets, thereby improving the speed at which faculty and students can complete research projects. The server would allow access to high performance hardware off campus. And finally, as previously described, the server would close the hardware/software equity gap for some students, enabling a greater number of students to become involved in the data processing/visualization stage of the research process. Currently, most of our students participate in research during the data collection stage. Additionally, the above curriculum enhancements using the JupyterHub server will allow us to engage our students sooner in their academic career with programming-related topics, so that we can involve both upper- *and* lower-division students in advanced research topics using the server. We find that students engaged in research are more likely to persevere through the challenging parts of the curriculum, making retaining and graduating students more likely.

e. Benefits to Unidata Community

The biggest value we have personally received from the Unidata community is the support, feedback, and assistance when implementing new hardware, software, and data analysis techniques into our teaching and research programs. The Unidata community actively listens to its end users to further improve their software suite. Many programs have initially chosen the cloud-based route for utilizing JupyterHub in their teaching and research. Deploying a physical JupyterHub server is still relatively uncommon amongst the community. One way we plan to give back to the community is by documenting and sharing lessons learned in deploying a physical JupyterHub server within a small, undergraduate specific program. ULM hopes to become a resource to the broader Unidata community on this topic. Faculty also plan to share any course materials developed using the server (i.e., Jupyter Notebooks) via GitHub.

3. BUDGET

The above equipment request will be purchased at the following cost:

Quantity	Item	Unit Cost	Total Cost
1	Dell Precision 7920 Server Rack	$15,044	$15,044
	Indirect Costs (45% on $0)		$0
	Grand Total Requested		**$15,044**

Per ULM's Facilities and Administrative rate agreement, overhead is not included on any equipment over $5,000. While there will not be any direct cost sharing by ULM, the PI, co-I's, and IT staff will donate time for the installation, configuration, and maintenance of the server. ULM is providing space in the primary server room for installation of the server. PI Murphy will

donate time to train other faculty on using Jupyter Notebooks. Specific manufacture quotes are included at the end of this proposal.

4. PROJECT MILESTONES

Vendor quotes have already been acquired which will facilitate placement of purchase orders immediately upon notification of an award in late May or early June 2022. The microprocessor supply chain continues to be strained, so this will likely lead to equipment arrival during the middle-to-latter half of the Fall 2022 term. Upon arrival, ULM IT personnel will install the server in ULM's primary server room and assist ATMS faculty on configuring the littlest JupyterHub distribution on the server. It's possible the JupyterHub server could be ready for incorporation into the broader ULM ATMS program by the start of the Spring 2023 term. However, more realistically, final testing will occur during the Spring 2023 term with full deployment at the start of Summer 2023 and curriculum enhancements occurring thereafter. After deploying the server, ULM personnel will note any lessons learned to share with the broader Unidata and geoscience community. Any course materials developed using the JupyterHub server will be shared via GitHub for distribution to the broader community. If the server arrives earlier than anticipated, then our timeline would move up slightly, but any additional supply chain disruptions would further delay this timeline.

GrantID: _____

University of Louisiana at Monroe Office Information Technology Request

Effective Date: August 15, 2008

Submit at least 15 working days before sponsor deadline

This screening form is used to identify potential conflicts of sponsored programs' technology component requests and ULM operating systems. Technology component approvals include, but are not limited to: computer hardware, software and networking requests.

Name:	Todd Murphy	University Title:	Associate Professor
Department/Unit:	ATMS/SOS	College:	CAES
Deadline:	3/25/22	Phone: 3428	E-mail: murphy@ulm.edu
Funding Agency:	UCAR Community Programs: Unidata Equipment Awards		
Project Title:	Deploying a JupyterHub Server to Support Education and Research at ULM		

Please use space below to describe technology/computer component of your proposal. Be as specific as your proposal allows you to be without revealing confidential or proprietary information which falls into a category described in Louisiana R.S. 44:4(16). If additional space is needed, attach a more complete description.

This proposal will request funds to acquire a JupyterHub server to better support deploying and enhancing Python based programming in the ULM Atmospheric Science program. The server would support approximately 20-30 active users using The Littlest JupyterHub distribution. The server would be installed by ULM IT and maintained by both IT and ATMS faculty. To ensure equitable access and to support virtual learning, we request the server to be accessible via the web, outside the primary ULM network. Students and faculty would have their own secruity credentials to log in to JupyterHub, starting a Jupyter Notebook to begin programming exercises, thereby not needing to install any special software or hardware on their personal computer.

By signing this form I affirm that the information stated in this form is true and accurate, and, further, that I accept responsibility of being familiar with ULM's policies and procedures on sponsored programs administration.

Principal Investigator

Todd Murphy

Date: 3/10/22

Office of Information Technology Approval

Reviewed/Approved by

Chance W. Eppinette

Date: 3-11-2022

OIT Comments

Working w/ Jimmy Waller, Adam Taylor & Chance Eppinette for dedicated server.
Approved.

School of Sciences
CNSB, Room 310
700 University Avenue | Monroe, LA 71209
P 318.342.1766 | F 318.342.1240

21 March 22

To: Unidata Grant Committee

The University of Louisiana at Monroe (ULM) School of Science (SOS), within the College of Arts, Education, and Science, strongly supports this Unidata Equipment grant proposal being led by Dr. Todd Murphy. The equipment will significantly enhance the research capabilities within the Atmospheric Science program, while supporting cross discipline research with additional areas in the SOS. This grant will further advance ULM's reputation in the atmospheric sciences community and bring potential for significant collaboration with external partners.

In addition to the research advantages, the JupyterHub server will significantly enhance undergraduate education at ULM and in the Department of Atmospheric Science. Student access to cutting edge research and data will be greatly expanded. The JupyterHub and data will be heavily featured in multiple courses thus allowing for greater emphasis on scientific computing and provide an abundance of experiential learning opportunities. Finally, this will improve the recruitment of high-quality students into the program, and the retention of current students.

Sincerely,

Anne Case Hanks, PhD
Director, School of Sciences
casehanks@ulm.edu
318.342.1822

A quote for your consideration

Based on your business needs, we put the following quote together to help with your purchase decision. Below is a detailed summary of the quote we've created to help you with your purchase decision.

To proceed with this quote, you may respond to this email, order online through your **Premier page**, or, if you do not have Premier, use this **Quote to Order**.

Quote No.	**3000115102116.1**	Sales Rep	Chika Christenson
Total	**$15,043.83**	Phone	(800) 456-3355, 6178999
Customer #	87419975	Email	Chika_Christenson@Dell.com
Quoted On	Mar. 16, 2022	**Billing To**	ACCOUNTS PAYABLE UNIV OF LA MONROE 700 UNIVERSITY AVE CONTROLLER'S OFFICE ADM 1-71 MONROE, LA 71209-9000
Expires by	Apr. 15, 2022		
Contract Name	Dell NASPO Computer Equipment PA - State of LA		
Contract Code	C000000010742		
Customer Agreement #	MNWNC-108/4400002525		
Solution ID	.		
Deal ID	22479080		

Message from your Sales Rep

Please contact your Dell sales representative if you have any questions or when you're ready to place an order. Thank you for shopping with Dell!

Regards,
Chika Christenson

Shipping Group

Shipping To

VP ACADEMIC AFFAIRS
UNIV OF LA MONROE
4100 NORTHEAST DR
MONROE, LA 71209
(318) 342-3548

Shipping Method

Standard Delivery

Product	Unit Price	Quantity	Subtotal
Precision 7920 Rack	**$15,043.83**	**1**	**$15,043.83**

Dell Marketing LP. U.S. only. Dell Marketing LP. is located at One Dell Way, Mail Stop 8129, Round Rock, TX 78682

Subtotal:	**$15,043.83**
Shipping:	**$0.00**
Environmental Fee:	**$0.00**
Non-Taxable Amount:	**$15,043.83**
Taxable Amount:	**$0.00**
Estimated Tax:	**$0.00**
Total:	**$15,043.83**

Dell Marketing LP. U.S. only. Dell Marketing LP. is located at One Dell Way, Mail Stop 8129, Round Rock, TX 78682

Shipping Group Details

Shipping To

VP ACADEMIC AFFAIRS
UNIV OF LA MONROE
4100 NORTHEAST DR
MONROE, LA 71209
(318) 342-3548

Shipping Method

Standard Delivery

		Quantity	Subtotal
Precision 7920 Rack	**$15,043.83**	**1**	**$15,043.83**

Estimated delivery if purchased today:
Apr. 29, 2022
Contract # C000000010742
Customer Agreement # MNWNC-108/4400002525

Description	SKU	Unit Price	Quantity	Subtotal
CPU Heatsink	338-BMIZ	-	1	-
CPU Heatsink	338-BMIZ	-	1	-
Intel Xeon Gold 6238R 2.2GHz,(4.0GHz Turbo, 28C, 10.4GT/s 2UPI, 38.5MB Cache,HT (165W) DDR4-2933 2nd)	338-BWQH	-	1	-
Intel Xeon Gold 6238R 2.2GHz,(4.0GHz Turbo, 28C, 10.4GT/s 2UPI, 38.5MB Cache,HT (165W) DDR4-2933 1st)	338-BWTK	-	1	-
Windows 10 Pro for Workstations (6 Cores Plus) Multi - English, French, Spanish	619-APRU	-	1	-
Not selected in this configuration	817-BBBC	-	1	-
Motherboard CL 7920 Rack	321-BENS	-	1	-
Dell Precision 7920 Rack Chassis	329-BDMU	-	1	-
QRL Label 7920 Rack	389-CGBJ	-	1	-
GPU Cables 7920 Rack	470-ACNW	-	1	-
USB 3.0 for R740	750-AAVV	-	1	-
Triple AMD Radeon Pro W5500, 8GB, 4 DP (Precision 7920R/7920T)	490-BGHJ	-	1	-
384GB 12x32GB DDR4 2933MHz RDIMM ECC Memory	370-AESK	-	1	-
Internal PCIe SSD (Dell Ultra-Speed Drive)	400-AGXX	-	1	-
C10 Dell Ultra-Speed Drive Boot (M.2 PCIe SSD) + SATA/SAS HDD/SSD Drives with RAID 0,1,5,10 (with PERC)	449-BBLQ	-	1	-
PERC H330+ Entry RAID Controller Card 12Gbps SAS/SATA (6.0Gb/s) RAID 0/1/5/10	403-BBQH	-	1	-
PERC Cable	403-BBRE	-	1	-
2.5 1.92TB SATA AG Enterprise Solid State Drive	400-BFXL	-	1	-
2.5"/3.5" HDD Carrier	575-BBOG	-	1	-
2.5 1.92TB SATA AG Enterprise Solid State Drive	400-BFXL	-	1	-
2.5"/3.5" HDD Carrier	575-BBOG	-	1	-
No Drive Selected	400-ATYN	-	1	-
No Drive Selected	400-ATYN	-	1	-
No Drive Selected	400-ATYN	-	1	-
No Drive Selected	400-ATYN	-	1	-
No Drive Selected	400-ATYN	-	1	-
No Drive Selected	400-ATYN	-	1	-

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RAID 1 for SATA HDD	780-BBCL	-	1	-
No Optical Drive	429-ABDZ	-	1	-
Not selected in this configuration	817-BBBC	-	1	-
M.2 512GB PCIe NVMe Class 40 Solid State Drive	401-ABGY	-	1	-
M.2 512GB PCIe NVMe Class 40 Solid State Drive	401-ABGY	-	1	-
Dell Ultra-Speed Drive Duo PCIe SSD x8 Card,	414-BBBT	-	1	-
C2Z Dell Ultra-Speed Drive Duo RAID 0 or 1, 2 PCIe NVMe Solid State Drives	405-AAQE	-	1	-
GPT is 100% required for all order	411-XXYB	-	1	-
GLOBAL OPTION UPDATE 00876242	580-ABIS	-	1	-
No Mouse	570-AADK	-	1	-
Thank You for Choosing Dell	340-ADBJ	-	1	-
Intel X710 DP 10Gb DA/SFP+, + I350 DP 1Gb Ethernet, Network Daughter Card	540-BBZS	-	1	-
US/Thailand/Philippines/Guam Power Cord	450-AAHH	-	1	-
US/Thailand/Philippines/Guam Power Cord	450-AAHH	-	1	-
Bezel	350-BBMK	-	1	-
Standard Left Ear - no Bezel	350-BBML	-	1	-
SERI Guide (ENG/FR/Multi)	340-AGIK	-	1	-
Placemat 7920 Rack	340-BTBI	-	1	-
OM Placemat	340-BVQC	-	1	-
Resource DVD not Included	430-XXYU	-	1	-
OS-Windows Media Not Included	620-AALW	-	1	-
Dell Precision Optimizer with AI	640-BBRC	-	1	-
US Order	332-1286	-	1	-
Ship Material 7920 Rack	328-BCQW	-	1	-
SHIP,PWS,LNK,NO,NO,AMF	340-AEYP	-	1	-
6 Standard Fans for R740/740XD	384-BBPY	-	1	-
No Accessories	461-AABV	-	1	-
ReadyRails Sliding Rails Without Cable Management Arm	770-BBKR	-	1	-
Dual Redundant Power Supply (1+1), 1100W	450-AGTJ	-	1	-
iDRAC9,Enterprise	385-BBKT	-	1	-
RAID 1 on M.2/U.2 PCIe NVMe SSD	780-BCIK	-	1	-
Intel VROC internal MB key	780-BCIP	-	1	-
Precision 7920 Rack XCTO Base	210-ALXM	-	1	-
Trusted Platform Module (Discrete TPM Enabled)	329-BBJL	-	1	-
Trusted Platform Module 2.0, V1328	461-AAEW	-	1	-
No Stand included	575-BBCH	-	1	-
iDRAC Group Manager, Disabled	379-BCQY	-	1	-
iDRAC,Legacy Password	379-BCSG	-	1	-
Performance Optimized	370-AAIP	-	1	-
SupportAssist	525-BBCL	-	1	-

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Dell(TM) Digital Delivery Cirrus Client	640-BBLW	-	1	-
Dell Developed Recovery Environment	658-BCUV	-	1	-
7920 Rack Regulatory Label	389-CGBI	-	1	-
Luggage Tag 7920 Rack	389-CGFM	-	1	-
No Anti-Virus Software	650-AAAM	-	1	-
No AutoPilot	340-CKSZ	-	1	-
Thank you choosing Dell ProSupport. For tech support, visit //support.dell.com/ProSupport	989-3449	-	1	-
Dell Limited Hardware Warranty Plus Service	997-5852	-	1	-
ProSupport: 7x24 Technical Support, 5 Years	997-5896	-	1	-
ProSupport: Next Business Day Onsite 5 Years	997-5966	-	1	-

Subtotal:	**$15,043.83**
Shipping:	**$0.00**
Environmental Fee:	**$0.00**
Estimated Tax:	**$0.00**
Total:	**$15,043.83**

Dell Marketing LP. U.S. only. Dell Marketing LP. is located at One Dell Way, Mail Stop 8129, Round Rock, TX 78682

Important Notes

Terms of Sale

This Quote will, if Customer issues a purchase order for the quoted items that is accepted by Supplier, constitute a contract between the entity issuing this Quote ("Supplier") and the entity to whom this Quote was issued ("Customer"). Unless otherwise stated herein, pricing is valid for thirty days from the date of this Quote. All product, pricing and other information is based on the latest information available and is subject to change. Supplier reserves the right to cancel this Quote and Customer purchase orders arising from pricing errors. Taxes and/or freight charges listed on this Quote are only estimates. The final amounts shall be stated on the relevant invoice. Additional freight charges will be applied if Customer requests expedited shipping. Please indicate any tax exemption status on your purchase order and send your tax exemption certificate to Tax_Department@dell.com or ARSalesTax@emc.com, as applicable.

Governing Terms: This Quote is subject to: (a) a separate written agreement between Customer or Customer's affiliate and Supplier or a Supplier´s affiliate to the extent that it expressly applies to the products and/or services in this Quote or, to the extent there is no such agreement, to the applicable set of Dell's Terms of Sale (available at www.dell.com/terms or www.dell.com/oemterms), or for cloud/as-a-Service offerings, the applicable cloud terms of service (identified on the Offer Specific Terms referenced below); and (b) the terms referenced herein (collectively, the "Governing Terms"). Different Governing Terms may apply to different products and services on this Quote. The Governing Terms apply to the exclusion of all terms and conditions incorporated in or referred to in any documentation submitted by Customer to Supplier.

Supplier Software Licenses and Services Descriptions: Customer's use of any Supplier software is subject to the license terms accompanying the software, or in the absence of accompanying terms, the applicable terms posted on www.Dell.com/eula. Descriptions and terms for Supplier-branded standard services are stated at www.dell.com/servicecontracts/global or for certain infrastructure products at www.dellemc.com/en-us/customer-services/product-warranty-and-service-descriptions.htm.

Offer-Specific, Third Party and Program Specific Terms: Customer's use of third-party software is subject to the license terms that accompany the software. Certain Supplier-branded and third-party products and services listed on this Quote are subject to additional, specific terms stated on www.dell.com/offeringspecificterms ("Offer Specific Terms").

In case of Resale only: Should Customer procure any products or services for resale, whether on standalone basis or as part of a solution, Customer shall include the applicable software license terms, services terms, and/or offer-specific terms in a written agreement with the end-user and provide written evidence of doing so upon receipt of request from Supplier.

In case of Financing only: If Customer intends to enter into a financing arrangement ("Financing Agreement") for the products and/or services on this Quote with Dell Financial Services LLC or other funding source pre-approved by Supplier ("FS"), Customer may issue its purchase order to Supplier or to FS. If issued to FS, Supplier will fulfill and invoice FS upon confirmation that: (a) FS intends to enter into a Financing Agreement with Customer for this order; and (b) FS agrees to procure these items from Supplier. Notwithstanding the Financing Agreement, Customer's use (and Customer's resale of and the end-user's use) of these items in the order is subject to the applicable governing agreement between Customer and Supplier, except that title shall transfer from Supplier to FS instead of to Customer. If FS notifies Supplier after shipment that Customer is no longer pursuing a Financing Agreement for these items, or if Customer fails to enter into such Financing Agreement within 120 days after shipment by Supplier, Customer shall promptly pay the Supplier invoice amounts directly to Supplier.

Customer represents that this transaction does not involve: (a) use of U.S. Government funds; (b) use by or resale to the U.S. Government; or (c) maintenance and support of the product(s) listed in this document within classified spaces. Customer further represents that this transaction does not require Supplier's compliance with any statute, regulation or information technology standard applicable to a U.S. Government procurement.

For certain products shipped to end users in California, a State Environmental Fee will be applied to Customer's invoice. Supplier encourages customers to dispose of electronic equipment properly.

Electronically linked terms and descriptions are available in hard copy upon request.

^Dell Business Credit (DBC):
OFFER VARIES BY CREDITWORTHINESS AS DETERMINED BY LENDER. Offered by WebBank to Small and Medium Business customers with approved credit. Taxes, shipping and other charges are extra and vary. Minimum monthly payments are the greater of $15 or 3% of account balance. Dell Business Credit is not offered to government or public entities, or business entities located and organized outside of the United States.