



The Digital Manufacturing Institute

MxD

REQUEST FOR QUOTATION

5G Private System Design
and Implementation

21-18-04

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I. RECORD OF CHANGE

Revision	Date	Sections	Description
1.0	14 October 2022	N/A	Original

II. TIMELINE

Deadline for submissions to be received	December 1, 2022
Follow up clarification meetings as needed	Throughout the submission phase
Feedback to participants	January 13, 2022

III. INTRODUCTION

MxD: The Digital Manufacturing Institute is where innovative manufacturers go to forge their futures. In partnership with the Department of Defense, MxD (also referred to as the Institute) equips U.S. factories with the digital tools and expertise they need to begin building every part better than the last. MxD's core mission is to transform American manufacturing, by fully integrating the digital thread across the manufacturing enterprise to reduce overall manufacturing costs, stabilize and grow the manufacturing industrial base and improve US competitiveness.

MxD has invested over \$120 million in more than 85 applied research and development projects in areas including design, product development, systems engineering, future factories, agile and resilient supply chains, and cybersecurity.

MxD operates from a nearly 75,000-square-foot innovation center near downtown Chicago. Its future factory floor features some of the most advanced manufacturing equipment in the world, which partners can use for experimentation and training on everything from augmented reality to advanced simulation techniques.

MxD is also the DoD's National Center for Cybersecurity in Manufacturing which focuses on three key areas. First, it uses its factory floor as a demonstration area for existing cybersecurity technology. Second, it works to develop new tools to address very specific pain points for manufacturers. And third, it is working with industry and government to figure out how to get these tools to small and medium-sized manufacturers. All MxD projects must take cybersecurity into consideration.

This RFQ is publicly available on the MxD website at <https://mxdusa.org/projects/>. This public posting represents the official notification of a request to submit the required documents. Amendments to an MxD RFQ may be used to extend due dates, clarify procedural requirements, or modify technical requirements. If an updated RFQ is issued, the previous RFQ will be rescinded. Those interested in responding to this RFQ should carefully monitor the MxD website after an original posting, up to the time of the quotation submission date. Any revisions, amendments or updates will appear in the same section of the website as the original solicitation. It is the responsibility of the respondents to monitor the MxD RFQ updates and ensure that their quotation meets the solicitation requirements.

The Respondent to an RFQ is the non-Federal organization that submits a quotation in response to the RFQ. The Respondent is considered the Prime contractor. Any other companies involved are considered Subcontractors typical of a Prime/Subcontractor relationship. All Subcontractors are subject to flow-down clauses in the Prime contract as required by all government stipulations.

Any questions regarding this solicitation must be provided to projects@mxdusa.org. The questions will be sent to the appropriate MxD point of contact, and answers will be published on the MxD website, if appropriate.



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TECHNICAL SUMMARY



IV. TECHNICAL SUMMARY

OVERVIEW AND BACKGROUND

This program seeks to establish a methodology to investigate the various types of 5G cellular architecture to determine the most appropriate configuration for use in manufacturing facilities. Infrastructure will be chosen for a 5G system to optimize the adoption of Industrial Internet of Things (IIoT) devices within buildings for digital technology applications. Both technical and business dimensions will be considered. The chosen 5G system will then be installed within the MxD research facility to provide a test platform for the formulation of instructional guides and exercise of specific uses cases to demonstrate benefits and/or limitations of the use of digital technologies within an industrial facility setting.

Items such as wireless sensors, control systems, and related equipment will be tested within the facility over various conditions. Test results, lessons learned, and best practices will be made available within a report suitable for publication. The 5G system will also serve as an ongoing testbed for industry and DoD for additional use cases in the future.

PROBLEM STATEMENT

Digital manufacturing involves many benefits that result from the focused use of data. This involves connecting factory floor sensors and other data sources to data centers or similar gathering points. This is done to collect, aggregate, and make data useful for identifying trends and opportunities to improve manufacturing operations. These connections can also be used to control the operation that the data is sourced from.

Traditionally, these data streams or points of data have been sent securely and with high integrity via hardwire in the factory environment. As the digital transformation advances, the use of sensors and other sources of data will be relied upon at an increasing rate. The cost and physical space to connect this equipment cannot be economically and efficiently done with hardwire. A wireless solution that allows flexibility, mobility and lower installation complexity and associated cost is a required substitute.

5G is often used in a singular context when talking about technology. However, 5G is made of several types of architectures and variables. These include low-, mid-, and high-band spectrum, standalone versus non-standalone architecture, private versus public, etc. Each of these configurations have interdependencies which make them unique in terms of performance, cost, complexity, capability, and control.

One of the impediments to the adoption of 5G wireless technology in manufacturing is the confusion caused by this ambiguity. Manufacturers are either not aware of the different configurations or do not have enough unbiased information to choose a configuration. Each configuration has pros and cons. No configuration is better or worse than other configurations when compared irrespective of an application. The challenge is to help manufacturers match which configuration is best for their individual application.

MxD Project 21-18-04 will focus on the generation of a testbed for 5G communications within an industrial setting that is capable of demonstrating and testing various 5G configurations. MxD desires to install the standalone, 5G private system within its Chicago innovation center to add



this additional 5G capability to its current setups, offering manufacturers, the DoD, and other Federal agencies access to utilize towards the testing of 5G client-side technologies. Such a testbed will be brand-agnostic, allowing the authentication of various SIMs within industrial systems, both present and future, to help demystify the implementation of wireless technologies in industrial architecture. Information gathered from this project will be utilized towards the later creation of a guide on 5G implementation within manufacturing and industrial settings. This approach will enable users of the testbed the opportunity to trial and de-risk various equipment and solutions independent of their own operations, which will help to lower the barriers to adopting 5G technology within their operations.

OBJECTIVES

The following objectives outline the key actions that MxD considers applicable for a successful implementation. “Mandatory” objectives are a minimum requirement of this RFQ. Failure to meet these objectives will disqualify the response from consideration. “Optional” objectives are purposely vague to allow Respondents flexibility and differentiation in their response. Respondents are encouraged to include “Optional” objectives where they see added value and relevance to MxD’s mission.

Mandatory

- Installation of a turnkey 5G New Radio (NR) standalone system
- System architecture will be based on Option 2 as defined in 3GPP TS 23.501 [16]
- The System will be private and completely on the MxD premises, without mandatory need for cloud access for normal system operation. However, nothing in the system design or components should inhibit cloud-based functionality in the future.
- The System must connect to the MxD intranet and/or internet as determined by MxD
- The System must operate in the Citizens Broadband Radio Service (CBRS) unlicensed spectrum
- The System must utilize spectrum access service (SAS)
- The System must be capable of virtual network / network slicing for different use case optimization
- System design, including Remote Radio Head (RRH) quantity and placement, must be such that coverage will include the areas of the MxD facility as specified in Attachment 1 with a signal strength of no less than -70 dBm
- The System’s core components must not inhibit future upgrades to 6 GHz unlicensed bands. It is understood that new/additional RRHs and/or software may be required.
- The System must be able to be maintained remotely as a service. Service must include monitoring, debug, and software updates/patching.
- The System must feature and require the logging and databasing of all SIMs that may be used in the system, including information on manufacturer, serial number, date/time when they were active in the System, and any additional information as deemed necessary by MxD.
- The System must have the ability to enable and disable SIMs remotely. MxD must be given access to and control of this feature
- The System must not use any integrated circuits or other critical infrastructure sourced from restricted countries or suppliers as specified by the US government at the time of release of this RFQ.



- All test equipment identified, procured, and operational, with validation during and after system install.
- Final documentation must include technical data package, system commissioning performance test results report and installation lessons learned report.

Optional

- Beamforming is desired to maximize throughput and enable location tracking.
- Applications which enable or enhance digital manufacturing capabilities, such as data aggregation or analytics, are desired.
- Core software and/or applications, beyond what is typically deployed in 5G systems, is desired which will further enhance cybersecurity.
- Educational material which can teach manufacturers topics such as component types, architecture, installation, maintenance, and security of 5G are desired. Material can include instructional books, lessons learned, software, video, and augmented reality tools as teaching aids.

A response to this RFQ must have a detailed, itemized breakdown of all mandatory and any optional items quoted.

SCOPE OF WORK

MxD Responsibilities

MxD will be responsible for any facility upgrades required by the System. This includes contractor selection, management, and payment for services. MxD will execute on these upgrades in a timely manner such that facility requirements do not delay System installation, provided adequate lead times are allowed. Upgrades include but are not limited to:

- Electrical power service including conduit and outlets and/or direct hookup to the System including RRHs per local code requirements.
- Ethernet hookup to the System including RRHs. This can be wire or fiber.
- Network hookup to the MxD intranet/internet
- Floor space and wall space required for the System footprint and RRHs. For clarification, this does not include hardware such as server racks or mounting brackets.
- Heating, ventilation, and air conditioning (HVAC) service
- Provide onsite and remote access as needed for installation and configuration

Respondents must specify and itemize all facility requirements in the RFQ response.

Respondent Responsibilities

Other than facility upgrades as mentioned above, the Respondent is responsible for all other aspects of System design, procurement, installation, configuration, and testing. This includes subcontract management with additional companies if required. Responsibilities, governed by Objectives above, include but are not limited to:

- System architecture and design including high-level design (HLD) and low-level design (LLD)



- Facility analysis including RF planning to determine RRH quantity and placement.
- The installation and operations of The System must not obstruct existing wireless systems at MxD. Any interference and overlap situations must be identified and resolved during the design and testing of the system.
- Complete an engineering RF site coverage analysis report of the MxD facility, both before and after system installation
- All System hardware for a turn-key system including RRHs and servers.
- All supporting hardware such as server rack and RRH mounting brackets
- All software for 5G core, virtualized radio access network (vRAN) central unit (CU) and distribution unit (DU), and network management
- All software required for remote maintenance service
- All software required for virtualization and network slicing capability
- Onsite installation of the system at MxD
- Pre-staged and/or onsite configuration
- Initial SAS setup and provisioning
- Initial tuning and testing of the system
- RF performance testing and facility coverage map generation
- Initial set of SIM cards and SIM provisioning in the unified data repository (UDR)
- Training of MxD personnel regarding system operation, configuration, and SIM provisioning
- Full system documentation including architecture schematics and bill of material/software.
- Implementation of an ongoing maintenance contract. This can be between MxD and Respondent or Respondent can refer MxD to another company.
- Respondent is responsible for all safety related aspects of the install, testing and final operations of the system
- Any requirements based on optional objectives included in the quotation.

The proposal shall include a Gantt chart detailing tasks and milestones required to achieve the project outcome.

A line-item breakdown of costs must be included in the proposal. Costs should be reasonable relative to current market rates and must adhere to any federal government guidelines.



Technical Deliverables: Table 1

Deliverable	Description	Due
Facility RF Study	Facility RF simulation, RRH placement plan, System rack placement plan, and forecasted RF performance for agreed upon areas from Attachment 1	Month 1
HLD and LLD Documentation	Documented system architecture, including hardware and software. Bill of material/software including vendor names and locations.	Month 2
System Installation and Configuration	Onsite installation of all hardware at MxD. Configuration of all software. Connection of RRHs and network. SAS configured and operational.	Month 3
System Test and Tune	SIMs configured. System RF performance and bandwidth performance tested. Facility RF coverage map completed.	Month 4
System Commissioning	Successful demonstration of System to MxD management. Documentation of System performance including bandwidth and RF coverage. Presentation of report of HLD/LLD design objectives verse measured performance.	Month 5
Training	Training of MxD personnel to operate the system and manage SIM card activation completed.	Month 5
Maintenance Contract	Execute a professional services contract with MxD for ongoing System maintenance or refer MxD to a qualified company.	Month 5
Optional Objective Demonstration	Implementation/Demonstration of any optional objectives included and agreed upon in the quotation/contract	Month 5



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PROGRAM OVERVIEW



V. PROGRAM REQUIREMENTS

PROGRAM MANAGEMENT

The selected Respondent will be awarded a contract as the Awardee. The Awardee is responsible for managing the project to ensure the team meets all the technical objectives and requirements as contracted based on the quotation. The Awardee will coordinate with the MxD point of contact (POC) for reporting purposes and for coordinating the integration at MxD. The MxD POC will monitor technical performance and project costs relative to the associated contract. The Awardee will submit the reports listed below in Table 1 to their MxD POC to fulfill their reporting requirements. These reports will be accessed by the MxD Senior Director PMO, MxD Director of Engineering, the MxD POC and other authorized staff members in the course of their official duties.

Program Deliverables: Table 2

Deliverable	Description	Due
Gantt Chart	Program schedule and milestones	Quotation Response
Program Review	Summary of progress towards of objectives and deliverables.	Weekly
Technical Documents and Test Reports	Per Technical Deliverables	Per Technical Deliverables
Safety Accident/Incident Report	Participants must report any major accident/incident (including fire) resulting in any one or more of the following situations: one or more fatalities or one or more disabling injuries; damage of Government property exceeding \$10,000; impact to Project planning or production schedules or degradation of the safety of equipment under contract. Such report will also identify potential hazards requiring corrective action.	Immediately on Occurrence
Government Required Documentation	Additional reporting based on government contractual requirements.	As Needed

PERIOD OF PERFORMANCE REQUIREMENTS

Estimated period of performance is 6 months from contract award. MxD is flexible on implementation time dependent on objectives quoted. However, there is no increase in funding beyond what was agreed to per contract.



TRAVEL, FACILITY ACCESS AND INSURANCE REQUIREMENTS

All travel requirements and associated costs needed for execution of the objectives and deliverables must be included in the quotation. There is no increase in funding should additional travel be required to fulfill the agreed upon requirements. Proposals must include an estimate for required travel known to be necessary to perform all work as defined above.

OWNERSHIP OF DELIVERABLES AND INTELLECTUAL PROPERTY

The contract will be a work for hire relationship. It is expected that the solution to meet the objectives will be a commercially available solution. Any existing, background intellectual property (IP) remains the property of the IP owner. Ownership and other rights in new IP produced as a result of the work performed under this contract will be determined at the time of contracting.

FUNDING REQUIREMENTS

MxD anticipates awarding a **fixed-price contract** resulting from this RFQ. MxD reserves the right to fund all, some, or none of the quotations received under issued RFQs. Final award amounts will be determined accordingly based on quotations received, subsequent evaluations, and final agreement between MxD and the Awardee.

Cost share is not required for this contract. However, cost share is encouraged to support the Institute's mission.

MxD recognizes the difficulty in completing a final, fixed-price quotation without additional information or site visits for certain projects. Therefore, **clearly document and explain all assumptions used to generate the quotation.**

If down selected, the Respondent will have the opportunity to gather additional details and revise the quotation. The Respondent must then submit substantiating documentation for costs (including any cost share). MxD will complete a comprehensive cost analysis (including cost reasonableness and cost realism) prior to contract award.

Neither MxD nor the U.S. Government has any responsibility for costs associated with development, submissions, or pre-award negotiations for this quotation and subsequent contract.

VI. ELIGIBILITY

MxD MEMBERSHIP

This RFQ is open to the public; any organizations regardless of membership status may submit a quotation in response to this RFQ. **Membership in MxD is not required to be awarded a contract as a result of this RFQ.**

If a Respondent or Awardee wishes to promote their affiliation with MxD as a result of this RFQ or subsequent award, MxD membership is required. This can include participation in workshops, social media promotion, and networking with other members. MxD membership does not grant rights to publish association with the project. Publication of association with the project will be subject to terms to be determined at the time of contracting.

Any Respondents who are non-MxD members are encouraged to review the Membership Agreement prior to submission and to direct questions to MxD's Director of Business



Development, Tony Papke (tony.papke@mxdusa.org). For more information on how to become a MxD Member, please visit the MxD Membership page on our website.

Federally Funded Research and Development Centers (FFRDCs) and Government entities (Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations and cannot propose to RFQs in any capacity unless they address the following conditions:

- FFRDCs or Government entities may not exclusively respond to this RFQ.
- FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector and must also provide a letter on letterhead from their sponsoring organization citing the specific authority establishing their eligibility to compete with industry and propose to solicitations utilizing Government funding.
- Government entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority, as well as, where relevant, contractual authority, establishing their ability to propose to solicitations utilizing government funding.

Government agencies interested in participating in MxD RFQs as a respondent or subcontractor should notify MxD in advance of the RFQ submission. For RFQs utilizing federal funding, special agreements and considerations may need to be implemented to enable participation.

NOTIFICATION OF PARTICIPATION NON-U.S. CITIZENS

Award shall be granted only to U.S. companies, firms, organizations, institutions, or other entities organized or existing under the laws of the United States, its territories, or possessions (as defined in Section 120.15 of International Traffic in Arms Regulations, 22 CFR § 120 et. seq. (“ITAR”)).

It is a requirement that work related to the Award must be completed in the U.S. by people legally authorized to work in the U.S. All proposed participation by non-U.S. Citizens must be disclosed to MxD on Attachment 1 non-U.S. Citizens at least 60 days prior to proposed participation. Written approval of non-U.S. Citizens must be received by the Awardee from MxD prior to commencing work.

VII. QUOTATION EVALUATION

EVALUATION PROCESS

An MxD Evaluation Board (EB) will review and evaluate each submitted quotation utilizing the evaluation criteria specified in the following section.

The EB may consist of recognized experts from industry and academia and key government stakeholder representatives (when appropriate). MxD representatives, such as the Senior Director of the PMO, Director of Engineering, MxD POC, may participate in and lead EB meetings. All members of the EB will need to meet strict standards of personal and organizational conflict of interest. The evaluators may be supported by subject matter experts to review and comment upon the proposed work.

Through its deliberations, the EB will determine “selectability” of each quotation. Selectability determination incorporates average EB judgement of objective compliance, budget availability, and overall perceived value. The EB will identify a list of quotations that are “selectable for



negotiation” to the MxD POC. The Senior Director PMO and the Director of Engineering, with the consultation of MxD POC, will determine which subset of the proposed quotations deemed “selectable for negotiation” will be down selected for negotiations. This determination will take into account the EB’s recommendation, funding availability, alignment with MxD’s mission and strategic goals as well as external stakeholder requirements (when applicable).

EVALUATION CRITERIA

Each quotation is evaluated by a specific set of criteria. Below are the quotation evaluation criteria for this RFQ:

Quotation Evaluation Criteria
<p>Requirements Compliance</p> <ul style="list-style-type: none"> • <i>Quoted solution clearly addresses all mandatory objectives identified in RFQ</i> • <i>Clear identification of assumptions, risks, and mitigations</i> • <i>Complete and clear itemization of all requirements</i> • <i>Program management plan meets requirements in the RFQ</i>
<p>Respondent Qualifications</p> <ul style="list-style-type: none"> • <i>Respondent and any proposed subcontractors highly qualified to accomplish objectives with clear delineation of roles and responsibilities</i> • <i>Respondent and any subcontractors have unique capabilities that are directly associated with the target technology</i>
<p>Cost Factors</p> <ul style="list-style-type: none"> • <i>Quoted costs are reasonable and realistic for the proposed work effort</i> • <i>Quoted costs are competitive relative to other commercial offerings</i> • <i>Value is maximized through inclusion of optional cost share and objectives</i>

VIII. PROJECT AWARDS

CONTRACT

The award of this contract will be subject to the requirements of the Collaboration Agreement between National Center for Manufacturing Sciences and MxD. All contractual negotiations related to RFQs will be executed by MxD. Funds will be distributed to the Awardee selected through the evaluation/selection process utilizing a fixed price contract.

FINAL REVISIONS

MxD reserves the right to negotiate the cost and scope of the proposed work with a Respondent that has been down selected prior to award. MxD will facilitate the creation of a Statement of Work with the Respondent including technical scope modifications and program management aspects. The Respondent and subcontractors, if any, who intend to pursue selection are required to



participate in the revision process prior to award. For example, MxD may request that the organizations revise the quotation to better align to RFQ requirements.

SUBMISSION DETAILS

Each Respondent must submit their quotation no later than **5:00PM Central Time, November 28th, 2022**. All submissions must be made on the MxD website. The SUBMIT button can be found on the program page at www.mxdusa.org/projects. By clicking the SUBMIT button, applicants will be directed to the official Submission Form.

IX. REFERENCES AND ACRONYMS

References: Table 2

Document Title	Document Number
US Code of Federal Regulation	N/A

Acronyms: Table 3

DoD	Department of Defense
EB	Evaluation Board
FAQ	Frequently Asked Question
FFRDC	Federally Funded Research and Development Center
IP	Intellectual Property
ITAR	International Traffic in Arms Regulations
PoC/POC	Point of Contact
PoP	Period of Performance
RFQ	Request for Quote



Attachment 1

Certification of Non-U.S. Citizens

___ There is NO participation by Non-U.S. Citizens proposed for this effort.

___ The following Non-U.S. Citizen is participating in this effort.

Non-U.S. Citizen Name, Contact Info	Country of Citizenship	Primary Employment Location	Employer	US Work Authorization (Visa, Green Card, Etc)	Justification*

*The Justification section should clearly outline the rationale behind the individual's request for participation, the type of data they will have access to, and other pertinent information regarding their skill set/expertise.