Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force												Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*					R-1 Program Element (Number/Name) PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	1,039.190	236.786	320.598	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1,596.574
643833: *MILITARY GLOBAL POSITIONING SYSTEM USER EQUIP*	1,039.190	236.786	320.598	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1,596.574
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		
Program MDAP/MAIS Code: 447												

A. Mission Description and Budget Item Justification

Note: "NAVSTAR" will be removed from the program title in this Budget Line Item in the next budget submission.

In FY2021, PE 1203164F, NAVSTAR Global Positioning System (User Equipment) efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1203164SF NAVSTAR Global Positioning System (User Equipment) from Appropriation 3600, Budget Activity 04 due to the creation of a new Appropriation for Space Force.

The Global Positioning System (GPS) is a space-based radio Positioning, Navigation, and Timing (PNT) distribution system. GPS User Equipment (UE) consists of standardized receivers, antennas, antenna electronics, and other related equipment, grouped together in sets to derive navigation and time information transmitted from GPS satellites. These receiver sets are used by the Department of Defense (DoD). Research, Development, Test and Evaluation (RDT&E) funds UE development, integration, test, and analysis for new PNT receiver capabilities in Navigation Warfare (NAVWAR) across all military platforms using GPS services.

The Military Global Positioning System User Equipment (MGUE) Increment (Inc) 1 program is responsible for the development of standard modernized receiver form factors for the Service-nominated lead platforms. The MGUE Inc 1 Capability Development Document (CDD) was approved by the Joint Requirements Oversight Council (JROC) on 24 July 2014. MGUE Inc 1 is initiating a new family of modernized GPS receivers that will deliver significantly improved capability to counter current and emerging PNT threats and enable military operations in a NAVWAR environment where current legacy receiver performance would be compromised. MGUE Inc 1 received a Milestone A decision in April 2012. The program received direction in February 2014 from the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) to execute a new acquisition strategy, accelerating the program to provide test units faster to facilitate military end users. The MGUE program received a Milestone B decision in January 2017.

The MGUE Inc 2 effort will continue to expand Military-Code (M-Code) receiver technology into additional applications (space receivers and precision guided munitions), and develop a modernized Handheld device to meet Service requirements. This effort leverages the MGUE Inc 1 technology to the maximum extent while addressing the production of M-Code integrated circuits far into the future. The MGUE Inc 2 program is being executed in three parts: 1) Risk Reduction Activities, 2) Miniature Serial Interface (MSI) Receiver Card Middle Tier Acquisition rapid prototyping, and 3) Joint Modernized GPS Handheld Receiver Middle Tier Acquisition rapid prototyping effort. The JROC approved the MGUE Inc 2 CDD on 6 April 2018. The Air Force Service Acquisition Executive approved the MGUE Inc 2 Acquisition

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*

Strategy to include designation of two Middle Tier Acquisition Rapid Prototype efforts: 1) Miniature Serial Interface (MSI) Receiver Cards to include next-generation Application Specific Integrated Circuit (ASIC) and 2) Joint, Modernized Handheld Receiver.

Space acquisition must respond with speed and agility to emerging adversary threats. Space & Missile Systems Center (SMC) is transforming the organization and implementation of space acquisition to an enterprise approach, maximizing innovation and resiliency, leveraging international, commercial, and mission partnerships, and managing program/project priorities according to an integrated unclassified/classified enterprise space architecture. Expanding the appropriate acquisition authorities and contract mechanisms to deliver capability sooner, SMC will strategically execute experimentation, prototyping, risk reduction, and other efforts to develop new or repurpose capabilities.

This Program Element (PE) may include necessary civilian pay expenses required to manage, execute, and deliver MGUE weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in PEs 1206392F and 1206398F.

This effort is in Budget Activity 4, Advanced Component Development and Prototypes (ACD&P), because efforts are necessary to evaluate integrated technologies, representative modes or prototype systems in a high fidelity and realistic operating environment.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	252.834	329.948	160.139	0.000	160.139
Current President's Budget	236.786	320.598	0.000	0.000	0.000
Total Adjustments	-16.048	-9.350	-160.139	0.000	-160.139
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	-9.350			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-7.407	0.000			
• SBIR/STTR Transfer	-8.641	0.000			
• Other Adjustments	0.000	0.000	-160.139	0.000	-160.139

Change Summary Explanation

FY 2019: -$7.407M for higher Air Force Space priorities.
FY 2020: -$9.400M Congressional Directed Reduction - maintain program affordability, unjustified growth
FY 2021: -$160.139M funds starting in FY 2021 were transferred from RDT&E, Air Force to RDT&E, Space Force.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: MGUE Inc 1	76.474	53.506	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: The MGUE Inc 1 program develops standard modernized receiver form factors for the Service-nominated lead platforms in accordance with the MGUE Inc 1 CDD. ***FY 2020 Plans:*** Continue the following: Verification Testing, Qualification Testing, Technical Requirements Verification, Lead Platform Integration, and Card level Program Executive Officer Certification for Operational Test and Evaluation (OT&E). Continue to assist each lead platform office in integrating and testing M-Code receivers in their respective platforms. Continue M-Code ASIC producibility analysis, risk reduction, and early engineering. Rapidly respond to implement system resiliency and situational awareness necessary to operate in the contested space domain. Continue program office and other related support activities that may include, but are not limited to studies, technical analysis, prototyping, etc. ***FY 2021 Plans:*** N/A ***FY 2020 to FY 2021 Increase/Decrease Statement:*** N/A			
Title: Advanced Technology ***Description:*** Advanced Technology includes efforts to mature technology for future GPS receivers called out in the MGUE CDDs. These efforts aim to find innovative solutions to increase resiliency in GPS performance and improve on size, weight, power, and cost (SWAP/C) of military receivers. ***FY 2020 Plans:*** Continue developing new technologies to augment U.S. Military GPS receiver development. Deliver first formal release of the M-Code Government owned intellectual Property for incorporation into vendor solutions, opening the M-Code market to additional participants, including simulator developers and small businesses. Develop test plans and procedures, perform testing and deliver reports on the incorporation of advanced trust / integrity algorithms that might permit military use of other Global Navigation Satellite System signals for delivering assured PNT. Start the prototype development of an integrated antenna, Antenna Electronics and MGUE receiver suitable for protecting SWAP constrained platforms in a future NAVWAR environment. Identify and assess algorithms and hardware implementations for integration of enhanced anti jam capability for SWAP constrained MGUE handheld receiver. ***FY 2021 Plans:*** N/A ***FY 2020 to FY 2021 Increase/Decrease Statement:***	13.885	5.097	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
N/A			
Title: System/Platform Integration and Performance Certification ***Description:*** Integration of MGUE Inc 1 receiver form factors into the Service-nominated lead platforms in support of developmental and operational test events. Conduct technical and operational modernization impact analysis for MGUE Service lead platform integration. ***FY 2020 Plans:*** Continue developmental test of the ground-based lead platform efforts. Continue Host Application Equipment (HAE) and system level integration for the air/maritime based lead platform efforts in support of developmental test. Continue lead platform integration efforts in support of operational test events. Assist DoD integration of M-Code GPS receivers for Joint Service non-lead platforms. ***FY 2021 Plans:*** N/A ***FY 2020 to FY 2021 Increase/Decrease Statement:*** N/A	49.445	61.396	0.000
Title: Information Assurance, Security/Compatibility Certification, and Test/Evaluation ***Description:*** Develop, implement, and maintain GPS security certification programs. Development of DoD Policy, strategy and resource requirements for MGUE security certification and compatibility certification. Security certification, compatibility certification, and security approval ensures future military GPS receivers protect critical program information and continue working in all environments and concepts of operations called for by U.S. Strategic Command. ***FY 2020 Plans:*** Continue to conduct security certification activities for all M-Code receivers, as required. Continue Modernized Security Evaluations/Tests for Selective Availability Anti-Spoofing Module (SAASM) and other legacy GPS receiver equipment. Review, approve, and track SAASM, M-Code receivers, and legacy receiver certified platforms and integrated applications for all of DoD. Continue to conduct delta certifications, as required. For the Ground Base-GPS Receiver Application Module-Military Code (GB-GRAM-M) complete the Technical Requirements Verification. Continue Requirements Verification and Reliability test activities as required to include approved engineering changes. Continue Lead Platform Integration test activities for the GB-GRAM-M MGUE vendors. ***FY 2021 Plans:***	5.830	13.194	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
N/A ***FY 2020 to FY 2021 Increase/Decrease Statement:*** N/A			
Title: MGUE Inc 2 Risk Reduction ***Description:*** The MGUE Inc 2 program will develop M-Code receiver technology for additional applications (space receivers, precision guided munitions, and handheld receivers) to meet Service requirements. MGUE Inc 2 Risk Reduction activities include, but are not limited to, acquisition strategy development, early design efforts through Preliminary Design Review (PDR) for the next generation ASIC using 14nm ASIC technology node, handheld design activities and early user demonstrations, advanced concept studies, receiver component prototyping to include MGUE Inc 2 requirements. ***FY 2020 Plans:*** Continue development of next generation ASIC and receivers, continue Preliminary Design Review (PDR), and purchase core ASIC technology and ASIC design/manufacturing/test support. Commence security certification evaluations and refine plans. Award up to 3 development contract(s) for new low size/power receiver to include next generation ASIC post-PDR and integration activities. Continue M-Code Handheld risk reduction activities, to include prototype evaluations. Rapidly respond to implement system resiliency and situational awareness necessary to operate in the contested space domain. Continue program office and other related support activities that may include, but are not limited to studies, technical analysis, prototyping, etc. ***FY 2021 Plans:*** N/A ***FY 2020 to FY 2021 Increase/Decrease Statement:*** N/A	91.152	187.405	0.000
Accomplishments/Planned Programs Subtotals	236.786	320.598	0.000

D. Other Program Funding Summary ($ in Millions)

Line Item	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
• SPAF 01 GPSSPC: *Navstar GPS Space*	2.181	0.000	-	-	-	-	-	-	-	0.000	2.181

Remarks

Space Procurement, Air Force (SPAF) funding in this PE supports legacy SAASM efforts. Similar work for the MGUE is in the planning phase.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*

E. Acquisition Strategy

The MGUE program has developed a comprehensive acquisition strategy to provide modernized GPS capabilities to U.S. and Allied Forces by developing a competitive market driven approach. This strategy establishes the signal compatibility and security criteria along with a process for evaluating components to enable rapid movement from development to fielding. The pillars of this effort are: (a) establishing time certain and low risk development; (b) bounding requirements to leverage mature technology to the maximum extent possible; (c) focusing on the development of form factors based on well-defined standards to support lead platform integration; and (d) implementing a proactive, collaborative MGUE platform integration activity to mitigate risk and reduce cost for DoD force structure modernization.

The MGUE program awarded three sole source contracts for the Inc 1 Technology Development Phase effort in September 2012, as follow-on efforts to the competitively awarded Modernized User Equipment (MUE) contracts awarded in June 2006. The effort spans the Technology Maturation and Risk Reduction Phase through design and includes integration and test of M-Code receivers into Service-nominated lead platforms. This effort also includes the security and compatibility certification of GPS receiver cards as a part of the integration effort. The Service lead platforms will select from the available vendors to integrate and perform operational testing with funding from the MGUE program. This supports compliance with PL 111-383, section 913.

The MGUE Inc 2 program developed an Acquisition Strategy to continue MGUE development by: addressing long term producibility of MGUE ASICs, identifying a U.S. owned trusted foundry for ASIC development, delivering GPS receiver cards to meet stringent Inc 2 requirements, and developing a modernized GPS handheld receiver to meet the needs of the Services. The MGUE Inc 2 program is being executed in three parts: 1) Risk Reduction Activities, 2) MSI Middle Tier Acquisition rapid prototyping, and 3) Joint Modernized GPS Handheld Receiver Middle Tier Acquisition rapid prototyping effort. The Air Force Service Acquisition Executive approved the MGUE Inc 2 Acquisition Strategy to include designation of two Middle Tier Acquisition Rapid Prototype efforts: 1) Miniature Serial Interface Receiver Card (includes next-generation ASIC) and 2) Joint, Modernized Handheld Receiver.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*	**Project (Number/Name)** 643833 / *MILITARY GLOBAL POSITIONING SYSTEM USER EQUIP*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2019 Cost	FY 2019 Award Date	FY 2020 Cost	FY 2020 Award Date	FY 2021 Base Cost	FY 2021 Base Award Date	FY 2021 OCO Cost	FY 2021 OCO Award Date	FY 2021 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
MGUE Inc 1 Technology Development	C/CPIF	Collins Aerospace : Cedar Rapids, IA	136.120	9.430	Nov 2018	12.584	Nov 2019	0.000		-		0.000	0.000	158.134	167.971
MGUE Inc 1 Technology Development (1)	C/CPIF	Raytheon : El Segundo, CA	179.113	15.678	Nov 2018	8.685	Nov 2019	0.000		-		0.000	0.000	203.476	211.320
MGUE Inc 1 Technology Development (2)	C/CPIF	L3Harris Tech : Anaheim, CA	96.635	10.687	Nov 2018	5.364	Nov 2019	0.000		-		0.000	0.000	112.686	120.189
MGUE Inc 1 Pre-Tech Development	C/CPAF	Various : Various	46.929	13.885	Jan 2019	5.097	Jan 2020	0.000		-		0.000	0.000	65.911	-
MGUE Inc 1 Demos	C/CPAF	Various : TBD	19.783	-		-		-		-		-	0.000	19.783	-
MGUE Inc 1 Platform Integration	C/CPAF	Various : Various	169.584	26.980	Nov 2018	45.326	Nov 2019	0.000		-		0.000	0.000	241.890	-
MGUE Inc 1 Compatibility Certification	C/CPAF	Various : Various	11.158	-		-		-		-		-	0.000	11.158	-
MGUE Inc 1 Information Assurance	C/CPAF	Various : Various	20.669	2.548	Jan 2019	2.706	Jan 2020	0.000		-		0.000	0.000	25.923	-
MGUE Inc 1 Security Certification	C/CPAF	Various : Various	31.374	1.539	Jan 2019	1.756	Jan 2020	0.000		-		0.000	0.000	34.669	-
MGUE Inc 1 Technical Mission Analysis	MIPR	Various : El Segundo, CA	41.756	18.231	Oct 2018	16.352	Oct 2019	0.000		-		0.000	0.000	76.339	-
MGUE Inc 1 Enterprise SE&I	C/CPAF	SAIC : El Segundo, CA	60.557	22.467	Nov 2018	16.070	Nov 2019	0.000		-		0.000	0.000	99.094	132.525
MGUE Inc 2 Risk Reduction	Various	Various : Various	108.400	86.760	Jan 2019	164.155	Jan 2020	0.000		-		0.000	0.000	359.315	1,013.400
MGUE Inc 2 Technical Mission Analysis	MIPR	Various : El Segundo, CA	2.510	0.000		4.100	Oct 2019	0.000		-		0.000	0.000	6.610	-
MGUE Inc 2 Enterprise SE&I	C/CPAF	SAIC : El Segundo, CA	2.020	1.101	Jan 2019	11.200	Nov 2019	0.000		-		0.000	0.000	14.321	97.300
		Subtotal	926.608	209.306		293.395		0.000		-		0.000	0.000	1,429.309	N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*	**Project (Number/Name)** 643833 / *MILITARY GLOBAL POSITIONING SYSTEM USER EQUIP*

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2019 Cost	FY 2019 Award Date	FY 2020 Cost	FY 2020 Award Date	FY 2021 Base Cost	FY 2021 Base Award Date	FY 2021 OCO Cost	FY 2021 OCO Award Date	FY 2021 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
MGUE Inc 1 Test and Evaluation	Various	Various : San Diego, CA	17.851	1.742	Jan 2019	8.732	Jan 2020	0.000		-		0.000	0.000	28.325	-
		Subtotal	17.851	1.742		8.732		0.000		-		0.000	0.000	28.325	N/A

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2019 Cost	FY 2019 Award Date	FY 2020 Cost	FY 2020 Award Date	FY 2021 Base Cost	FY 2021 Base Award Date	FY 2021 OCO Cost	FY 2021 OCO Award Date	FY 2021 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
MGUE Inc 1 FFRDC	Various	Aerospace/MITRE : Various	51.790	5.597	Dec 2018	5.929	Dec 2019	0.000		-		0.000	0.000	63.316	-
MGUE Inc 2 FFRDC	Various	Aerospace/MITRE : Various	2.500	0.000	Dec 2018	2.600	Dec 2019	0.000		-		0.000	0.000	5.100	-
MGUE Inc 1 A&AS	Various	Various : Various	37.430	16.423	Dec 2018	4.163	Dec 2019	0.000		-		0.000	0.000	58.016	-
MGUE Inc 2 A&AS	Various	Various : Various	1.400	3.291	Dec 2018	5.350	Dec 2019	0.000		-		0.000	0.000	10.041	-
MGUE Inc 1 and Inc 2 Other Support	Various	Various : Various	1.611	0.427	Dec 2018	0.429	Dec 2019	0.000		-		0.000	0.000	2.467	-
		Subtotal	94.731	25.738		18.471		0.000		-		0.000	0.000	138.940	N/A

	Prior Years	FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	1,039.190	236.786		320.598		0.000		-		0.000	0.000	1,596.574	N/A

Remarks

MGUE Inc 2 Risk Reduction ($164.115M) previously consolidated FY20 ASIC ($139.115M), MSI ($15.4M) Handheld($9.6M). There is no cost change in FY20.

Exhibit R-4, RDT&E Schedule Profile: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*	**Project (Number/Name)** 643833 / *MILITARY GLOBAL POSITIONING SYSTEM USER EQUIP*

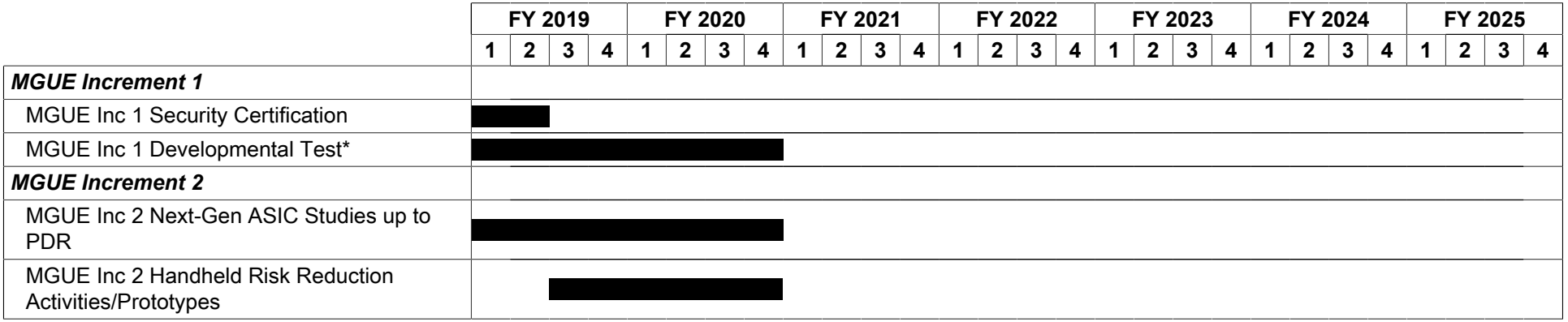

Exhibit R-4A, RDT&E Schedule Details: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1203164F / *NAVSTAR Global Positioning System (User Equipment) (SPACE)*	**Project (Number/Name)** 643833 / *MILITARY GLOBAL POSITIONING SYSTEM USER EQUIP*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
MGUE Increment 1				
MGUE Inc 1 Security Certification	1	2019	2	2019
MGUE Inc 1 Developmental Test*	1	2019	4	2020
MGUE Increment 2				
MGUE Inc 2 Next-Gen ASIC Studies up to PDR	1	2019	4	2020
MGUE Inc 2 Handheld Risk Reduction Activities/Prototypes	3	2019	4	2020

Note

All 5 form factors will go through some form of Developmental Test. Per the MGUE Inc 1 Acq Strategy however, only the first card of each variant (GB-GRAM-M/GRAM-S/M) will go through formal Operational Test. OT could/would complete on the "first card" while other form factors continue to go through DT.