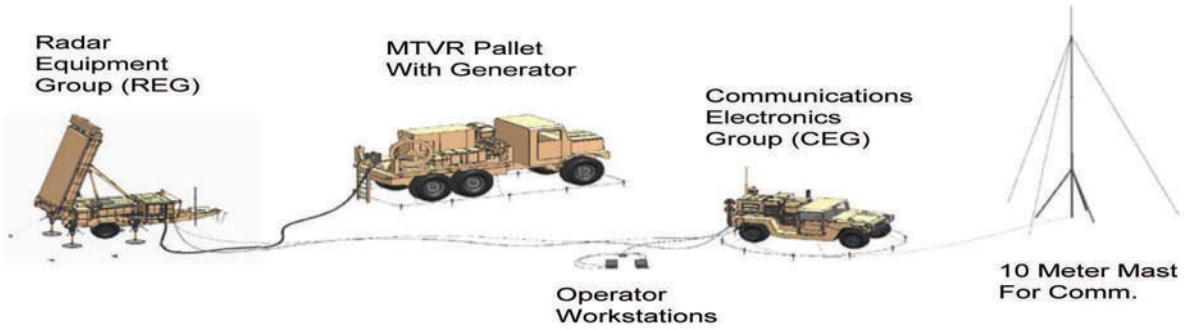
Ground Air Task Oriented Radar (G/ATOR)



The Ground/Air Task-Oriented Radar (G/ATOR), in development by the Marine Corps, is a three-dimensional short-to-medium-range tactical radar designed to detect, identify, and track low-level cruise missiles, manned aircraft, and unmanned aerial vehicles as well as rockets and mortar and artillery fire. Due to advances in digital radar technology, the G/ATOR will be a highly mobile, multi-role radar system that will perform the functions of five different legacy ground-based radars it is slated to replace; providing increased range, accuracy, tactical mobility, and reliability.

The radar will perform air surveillance, cue air defense weapons, perform counter-fire target acquisition (of enemy artillery and mortar firing locations), and provide data to air traffic controllers. Consolidating these functions into a single multi-role radar will dramatically reduce Marine Corps logistics, operating, and training costs.

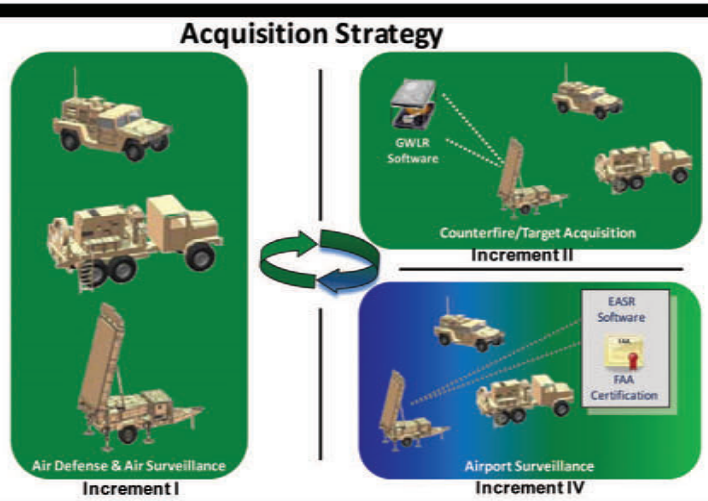
The G/ATOR program is currently in the engineering and manufacturing development phase; Northrop Grumman Electronic Systems in Baltimore, MD, is the prime contractor. The entire G/ATOR system is transported by only two up armored vehicles – a six-wheel, 7-ton Medium Tactical Vehicle Replacement (MTVR) all-terrain truck built by Oshkosh, and a single HMMWV. In G/ATOR's operational configuration, its large radar antenna array is mounted on an integrated trailer towed by the MTVR vehicle, and is folded down flat during movement. The antenna array remains on the trailer during all operations, and is electro-mechanically elevated and leveled for use. The MTVR truck carries a pallet with a generator and support equipment. The HMMWV carries the radar system's palletized Communications-Electronic Group (CEG). Both pallets can be self-extracted from the vehicles.

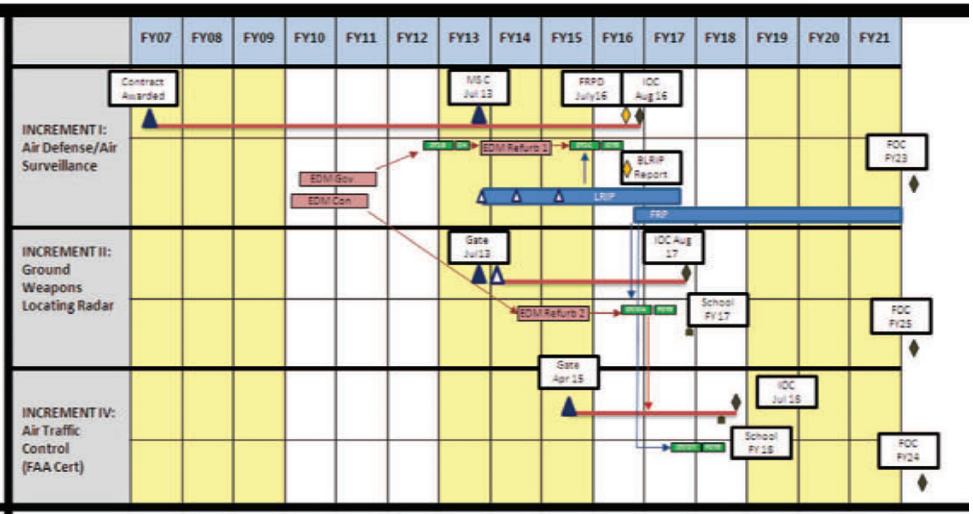
G/ATOR will be fielded over time in increments. Increment I, scheduled for an initial operational capability (IOC) and a full rate production decision in 2016, is the air surveillance and short-range air defense radar, which will replace the AN/TPS-63, AN/MPQ-62, and AN/UPS-3 radars. Increment I will provide all the basic hardware for future increments, which will add new capabilities through mission-specific software packages. Increment II, slated for an IOC in 2017, will add the enemy rockets, artillery and mortar target locating capability, replacing the existing

AN/TPQ-46 radar. Increment IV, scheduled for an IOC in 2018, will add military air traffic control functionality, replacing the Marine Corps' AN/TPS-73 radar and the Airport Surveillance Radar portion of the AN/TPN-31A Air Traffic Navigation, Integration, and Coordination System. Increment III, which encompassed tactical enhancements to the other increments, has been deferred until the other three increments are developed. The incremental program will allow the Marine Corps to "neck down" over time to only two primary radars – the expeditionary short-to-medium- range G/ATOR and the large, transportable AN/TPS-59(V)3 long-range air surveillance radar. G/ATOR Increment I also will serve as a gap filler radar, covering areas out of view of the TPS-59(V) 3 due to line-of-sight limitations. With the exception of the MTVR vehicle, the major G/ATOR system components – the trailer with antenna array, the HMMWV with the CEG pallet, and the generator pallet – will be transportable in external sling loads by Marine Corps heavy-lift helicopters and MV-22 Osprey tilt-rotor aircraft. The key to achieving G/ATOR's multi-role capabilities within a highly mobile expeditionary system is Active Electronically Scanned Array (AESA) radar technology. Unlike mechanically scanned radars with curved-dish antennas, an active phased-array radar can steer its agile beams electronically. G/ATOR's antenna array is made up of many highly reliable small solid-state transmit-receive modules, each a small radar in itself that can alternate between transmitting and receiving. AESA radars can operate in multiple modes simultaneously and can track significantly more targets than older systems.

G/ATOR provides 360-degree coverage against airborne threats, mechanically scanning in azimuth and electronically scanning in elevation. For some missions, the antenna will be stationary and will scan a sector of the airspace it is facing electronically in two dimensions – azimuth and elevation. The need to keep weight down to allow the radar system to be air lifted with rotary-wing aircraft drove to an air-cooled array instead of a more common but much heavier closed-loop liquid cooling system. The array has to be kept at a constant temperature across all of its transmit-receive modules for peak performance, and the air cooling has proven to be very effective. G/ATOR has a larger array and sees literally twice as far as the legacy systems it will replace; it's much lighter, primarily due to the AESA active elements on the array and the air cooling system. In March 2009, Northrop Grumman successfully completed the G/ATOR program's Critical Design Review, the final hurdle before the company began building the first Increment I engineering development model (EDM) prototype system. Northrop Grumman now has two EDMs undergoing contractor integration and testing, with Government Developmental Test scheduled to begin in July of 2012. Milestone C approval for low-rate initial production of the G/ATOR Increment I radar system is scheduled in 2013. The Marine Corps' Approved Acquisition Objective is a total of 67 G/ATOR systems – 17 Increment I radars, 38 Increment IIs, and 12 Increment IVs.

Ground/Air Task Oriented Radar
AN/TPS-80 G/ATOR





Mission & Requirements

- 3D, short/medium range multi-role radar designed to detect unmanned aerial systems, cruise missiles, air breathing targets, rockets, artillery and mortars.
  - Satisfies Warfighters' expeditionary needs across MAGTF spectrum
- Replaces five legacy radar systems with a single MAGTF solution:

AN/UPS-3 Tactical Defense Alert	Inc I	Air Defense/Surveillance
AN/MPQ-62 Continuous Wave Acq	Inc I	Air Defense/Surveillance
AN/TPS-63 Air Surveillance	Inc I	Air Defense/Surveillance
AN/TPQ-46 Counter-Battery/ Target Acq	Inc II	Ground Weapons Locating
AN/TPS-73 Air Traffic Control	Inc IV	Air Traffic Control

Capability/Improvements

- Increased range, accuracy, tactical mobility and reliability
- One system through tech insertion leveraged from prior variants:

Inc I:	Air Defense/Surveillance Radar (ADSR)	Qty 17
Inc II:	Ground Weapons Locating Radar (GWLR)	Qty 28
Inc IV:	Expeditionary Airport Surveillance Radar (EASR)	Qty 12
	AAO Qty	57

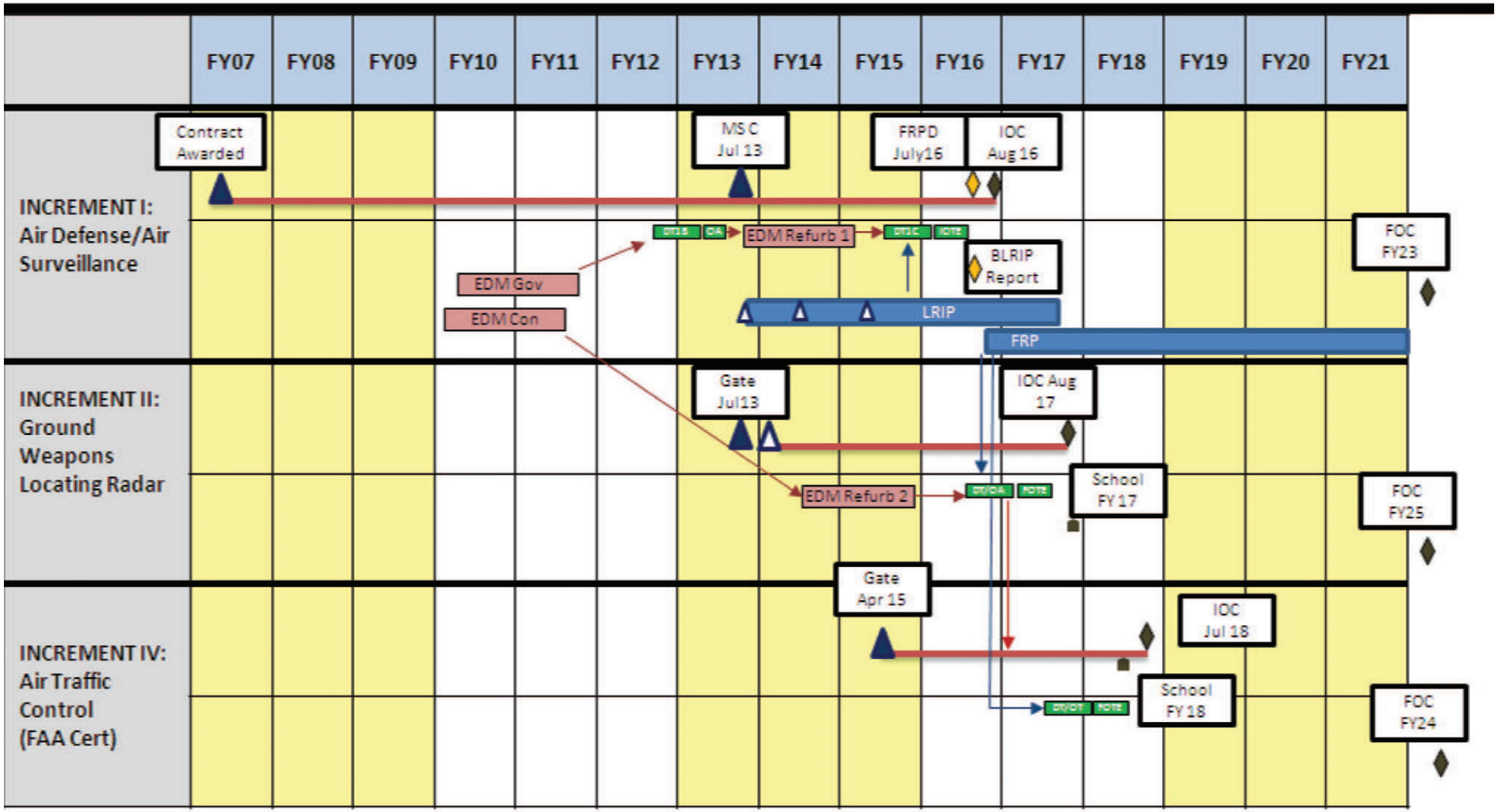
Recent History

- MROC of March 2010 endorsed proposed program plan
- Increment III Mode 5/S capability absorbed into Increment IV—all other Increment III capabilities deferred
- Resourced in PB 12
- Increment IV funding remains a BISOG issue
- Designated ACAT IC by AT&L ADM 28 Oct 2011
- MCCDC AAO change to 57

Upcoming Events

- FY12
  - Developmental Testing: DT 1B1/1B2
  - Production Readiness Review
- FY13
  - DT1B3 and Operational Assessment
  - Milestone C Decision
  - LRIP contract award

Ground/Air Task Oriented Radar
AN/TPS-80 G/ATOR



Ground Air Task Oriented Radar (G/ATOR)

G/ATOR's Top Three Program Technology Issues:

1. Lowering Manufacturing Costs - Overall system production costs are high. Multiple areas of production are being evaluated for cost savings, including: (1) Air ducts that provide precise mounting and cooling of the T/R Modules and array elements. The air duct is very time consuming to produce and assemble and thus very expensive. (2) T/R Module packaging requires expensive materials and hermetic sealing which reduces yield. (3) Circulator Isolator Resistor Filters boards required for T/R Module requires multi-step medium yield manufacturing process.

2. Transit/Receive (T/R) Module Efficiency - The G/ATOR system currently operates at the limit of its prime power source. As the largest aggregate consumer of power, the T/R modules low power efficiency has been targeted for improvement. (1) Higher efficiency power amplification, (2) higher efficiency DC/DC power supply, and (3) greater integration of components are specific areas being considered for improvement.

3. GaN Reliability - Enhancements in GaN based integrated circuits can potentially reduce costs and increase performance for the T/R modules of the radar. GaN integrated circuits has proven able to handle higher heat and higher frequencies but there remain some reliability challenges in producing the integrated circuits.

1. Lowering Manufacturing Costs:

1a. Active S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR Phase I)

1b. Potential S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR Phase I)

Other

- Gator Phase A Study Reduce the cost of the TRMs

2. Transit/Receive (T/R) module Efficiency (Power):

2a. Active S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)

2b. Potential S&T Initiatives for G/ATOR

TARDEC

- Ground Vehicle Power & Mobility (GVPM) Vehicle Integrated JP8 Fuel Cell APU System

Exploration & Development (E&D)

- Integrated Power and Propulsion

Other

- On-Board Vehicle Power Systems Development

3. GaN Reliability:

3a. Active S&T Initiatives for G/ATOR

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)

3b. Potential S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I)

Other

- Develop & Demonstrate a GaN T/R Switch - QRF

G/ATOR Technical Issue #1 Lowering Manufacturing Costs

G/ATOR	2011	2012	2013	2014	2015	2016	2017

Program Milestones/ Insertion Points

C — MS-C

FRPD — IOC

Active and Potential Investment Opportunities

Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR Phase I) — 4

High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR Phase I) — 5

G/ATOR Phase A Study Reduce the cost of the TRMs

D&I | E&D | FNC | SBIR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL
C.15
C.16
P.02

MCTL
MCT 1.3.1
MCT 5.3.5.1
MCT 5.3.5.5
MCT 6.1.2.3

JWC

→ **MGL**
F.05-13
F.05-10
M.05-04

→ **STO'S**
LOG STO-6

→ **Technology**
-Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits
-High-Efficiency Solid-State S&X-Band Radar Power Amplifiers
- Reduce the cost of the TRMs

→ **Venues**
SBIR
QRF

→ TTA → POM Funding → T

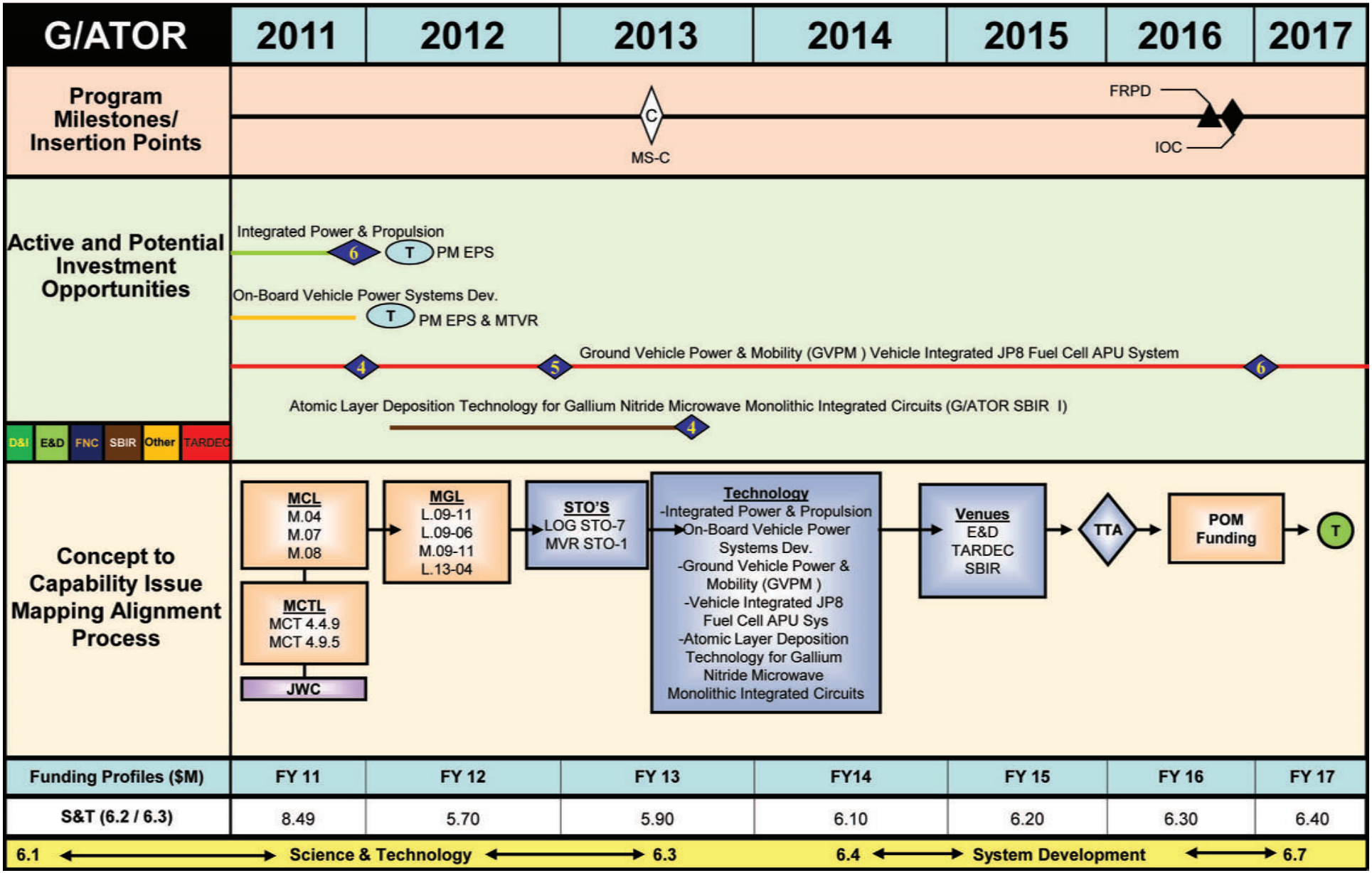
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.1	0.1	0.1				

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

G/ATOR Technical Issue #1 Lowering Manufacturing Costs

MCL	C.15 Maintain relevant information C.16 Process information P.02 Protect personnel, physical assets and LOCs		
MCTL	MCT 1.3.1 Conduct Maneuver MCT 5.3.5.1 Conduct Air Direction MCT 5.3.5.4 Conduct Airspace Control MCT 5.3.5.5 Coordinate/Employ Airspace Control Measures MCT 6.1.2.3 Conduct Passive Air Defense		
MGL	F.05-13 Indirect Fire Detection Correlation and Networking Capability F.05-10 Indirect Fire Detection Capability M.05-09 Indirect Fire Warning Capability		
STO'S	LOG STO-6 Materials for reduced maintenance		
Technology	Active: Atomic Layer Deposition Tech for GaN Mwave Monolithic Integrated Circuits Phase A Study Reduce the cost of theTRMs	Pending: N/A	Potential: High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR)
Venues	QRF, SBIR		
TTA	N/A		
POM Funding	MCCDC integration Division		
T	Transition to a program of record	Comments/Issues:	

G/ATOR Technical Issue #2 T/R Module Efficiency (Power)



Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	8.49	5.70	5.90	6.10	6.20	6.30	6.40

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

G/ATOR Technical Issue #2 T/R Module Efficiency (Power)

MCL	C.20 Optimize networks L.02 Maintain equipment M.02 Maneuver to engage kinetically	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power generation/ distribution	
STO'S	LOG STO-7 Materials for reduced maintenance MVR STO-1 Advanced power plants, drive trains and suspensions	
Technology	Active: Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)	Potential: On-Board Vehicle Power Systems Dev. -Ground Vehicle Power & Mobility (GVPM) -Vehicle Integrated JP8 Fuel Cell APU Sys -Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits
Venues	E&D, Plus-Ups, QRF	
Army		
TTA	No TTAs are required	(T) Transition target for: PM MTVR, EPS
POM Funding	MCCDC integration division	
(T)	Transition to a program of record	Comments/Issues:

G/ATOR Technical Issue #3 GaN (Gallium Nitride) Reliability

G/ATOR	2011	2012	2013	2014	2015	2016	2017

Program Milestones/ Insertion Points

C — MS-C

FRPD — IOC

Active and Potential Investment Opportunities

Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I) — 4

High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I) — 5

Develop & Demonstrate a GaN T/R Switch - QRF

D&I | E&D | FNC | SBIR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL
C.06
C.14
C.20

MCTL
MCT 1.3.1
MCT 5.3.5.1
MCT 5.3.5.5
MCT 6.1.2.3

JWC

→ **MGL**
C.14-03
L.03-01

→ **STO'S**
MVR STO-1
MVR STO-2
FIRES STO-2

→ **Technology:**
-Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits
-High-Efficiency Solid-State S&X-Band Radar Power Amplifiers
-Develop & Demonstrate -a GaN T/R Switch

→ **Venues**
QRF
SBIR

→ TTA → POM Funding → T

Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.1	0.1	0.1				

6.1 ⟷ Science & Technology ⟷ 6.3 | 6.4 ⟷ System Development ⟷ 6.7

G/ATOR Technical Issue #3 GaN (Gallium Nitride) Reliability

MCL	C.06 Synchronize execution across all domains C.14 Create/produce information C.20 Optimize networks	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 5.3.5.1 Conduct Air Direction MCT 5.3.5.5 Coordinate/Employ Airspace Control Measures MCT 6.1.2.3 Conduct Passive Air Defense	
MGL	C.14-03 Limited Transport Capability L.03-01 Sustainment Distribution	
STO'S	MVR STO-1 Advanced power plants, drive trains, and suspensions MVR STO-2 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles FIRES STO-2 Integrated lightweight day-night optics	
Technology	Active: Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)	Potential: High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I) Develop & Demonstrate a GaN T/R Switch - QRF
Venues	Quick Reaction Fund , SBIR	
Army	N/A	
TTA	No TTA is required.	
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues: