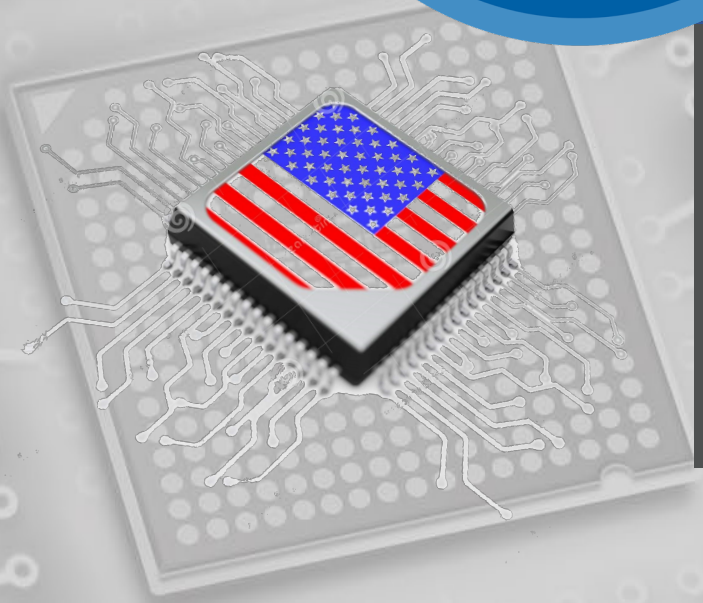
AME GEM

Microcircuit Emulation Center
MADE IN THE USA
New Jersey Est. 1987
SRI International



# A Solution for Microcircuit Obsolescence

## Generalized Emulation of Microcircuits (GEM) Program

Michael Patti
GEM Program Manager
SRI International

2024 F-15 TCP Worldwide Review

# SRI International

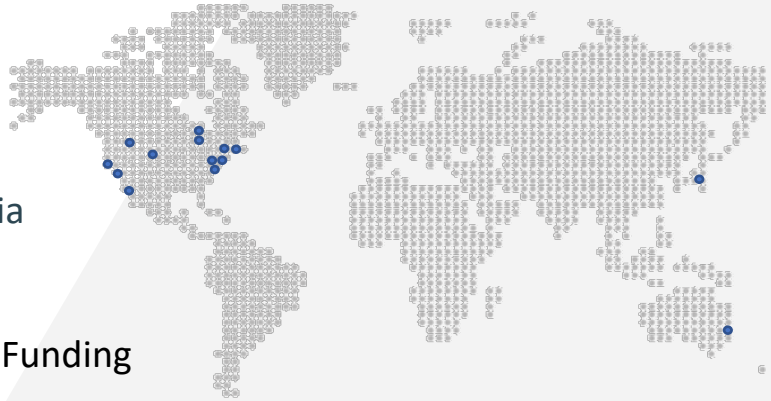
Independent, Nonprofit Institute, Supporting Government and Industry

## Mission

**SRI** creates **WORLD-CHANGING SOLUTIONS** making people safer, healthier, and more productive

## Structure

**HQ** in Silicon Valley
**14** locations in U.S.
+ Japan & Australia
**40+** research groups
**1,200+** Staff
**$400M** Annual R&D Funding



## Legacy

Founded in 1946 by Stanford University

## Research & Manufacturing Focus

### Human Augmentation

Intelligent interactive systems that augment human abilities

### Automation & Infrastructure

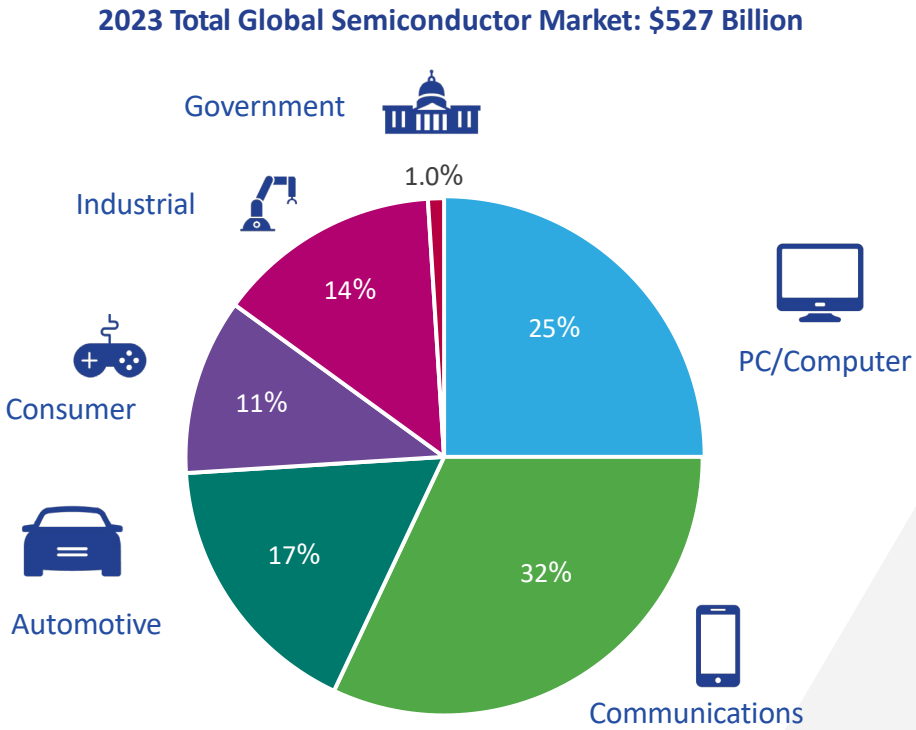
Smart and secure systems that enhance capacity, capability and connectivity

### Healthcare

Technologies that improve patient outcomes and lower healthcare costs

DARPA
I A R P A
BE THE FUTURE
NORTHROP GRUMMAN
BAE SYSTEMS
Raytheon

# The Obsolescence Problem



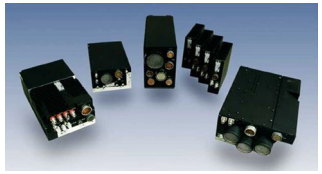

**Source: Semiconductor Industry Association Fact Book 2024**

## Details

- Obsolescence is economics driven
  - Building facilities costs $Billions
  - Maintaining costs $Millions
  - Manufacturing only cost effective in high volume
  - Manufacturers apply resources ($$) to high return markets
- Military is the smallest slice at 1% of total market
- Today's new products are shortening microcircuit lifecycles

# The Effect of Microcircuit Obsolescence on Weapon Systems

A single unavailable microcircuit affects operational readiness at every level

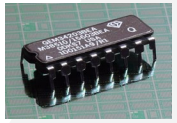


Sub-systems/Units:
LRUs, WRAs, Boxes

Need

Assemblies:
PCBs, CCAs, SRUs, SRAs

Need



Components:
Microcircuits, Chips, ICs

Need

Manufacturing:
Design, Fabrication, and QCI Testing

# What is Needed to Address the U. S. Government's Need of Microcircuits?

- U. S. based on demand manufacturer
  - Can manufacture in small volumes
  - Long gaps between production runs
- Continuous manufacture of existing product
  - Wafer process technology is never obsoleted
  - Design databases maintained for many years
- Qualified as a QML manufacturer
  - Compliance to MIL-PRF-38535 testing and manufacturing
- Large microcircuit product portfolio
  - Ability to design, manufacture, and test many types of microcircuits
- Can design and manufacture legacy microcircuits
  - Reverse engineer existing specifications and microcircuits
  - Form, fit, and function replacement with no changes to existing hardware or software

## Commercial Challenges

- Wafer fabs need high volumes to be economically viable
- Difficult to support and maintain a large portfolio of microcircuits
- Cannot justify the economics of supporting the 1% market share for Government needs

## What is GEM?

**G**eneralized
**E**mulation of
**M**icrocircuits

## DLA & SRI International

- GEM is a DLA Program, providing military grade microcircuits
- SRI International (formerly Sarnoff Corp.) is DLA's prime contractor for the GEM Program, located in Princeton, NJ
- GEM was created to fill a void; continue to supply microcircuits when the industrial community no longer will manufacture, and the aftermarket supply has dried up
- The GEM program does not compete with industry
- Program goal is to support the Warfighter with a cost-effective, long-term solution for sustainment

Maintain Capability to Produce Unavailable Microcircuits

# SRI's Microcircuit Emulation Center

*All Manufacturing at SRI's Microcircuit Emulation Center in Princeton, NJ (formerly Sarnoff Corporation)*

## Reverse Engineering

- Characterization of electrical performance
- Physical delayering of silicon and GDSII recreation
- Design recovery

## Design & Layout

- Full-suite of state-of-the-art EDA tools
- Foundry capabilities modeled and integrated into design flow

## Microcircuit Manufacturing

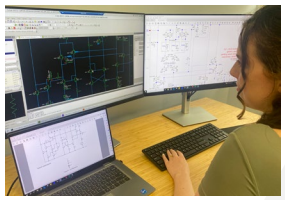
- 25,000 $ft^2$ Clean Room, Class 10 & 100
- Government Trust Accreditation
- QML manufacturing
- SPC manufacturing process covering all process areas

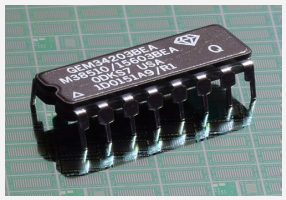
## QML Testing

- Reliability and Functional ATE characterization
- QML Certified test flow (MIL-PRF-38535)
- Lab suitability Certified

## Available Microcircuit

- Form, Fit, Function, & Interface replacement Class Q Microcircuits





# New Emulation Lead Time

*On-Demand Manufacturing Volume Can Affect Lead Time*

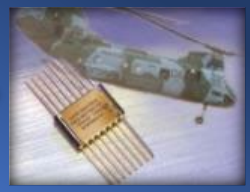
**CUSTOMER PROVIDED**
Specification
Design Data
Functional
Samples

**Logic Family Microcircuits**
34 – 48 weeks

**Reverse Engineering & Design**
(12-18 weeks)

**Wafer and Packaging**
(10-12 weeks)

**Test and Qualification**
(12-18 weeks)



**Memory, PALs, or ASIC Microcircuits**
More than
52 weeks

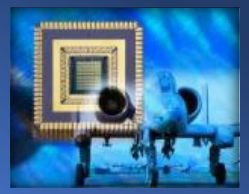
**Reverse Eng. & Design**
(28-

**Wafer & Packaging**
(10-12 weeks)

**Prototype Test**
(4-8 weeks)

**Customer Insertion Test**
(if required)

**Test & Qual.**
(10-22 weeks)



Available inventory delivered in 2 - 6 weeks

# U.S. Based Wafer Facility

- No dependency on outside wafer facility
- Allows for continuous on demand manufacturing

| Technology Node | >3.0 µm | 1.5 µm | 1.2 µm | 0.8 µm | 0.5 µm | 0.35 µm |
|---|---|---|---|---|---|---|
| Process Technology | CMOS BiCMOS HV CMOS | CMOS BiCMOS HV CMOS | CMOS BiCMOS | CMOS Bipolar DTI Schottky | CMOS SOI | LV CMOS |
| Metal Layers | 2 levels | 2 levels | 3 levels | 3 levels | 3 levels | 5 levels |




# Permanent Solution Example

- **GEM Part No. GEM06001BAA**
  - Emulation of M38510/02601BAA
  - NSN No. 5962-01-423-9501
  - Generic part number 54L86 in a flat-pack package
    - Initially designed and manufactured in 1997
    - Multiple delivery orders during 1997 - 2004
- **DLA Purchase Order received February 2021**
  - Requested part no. M38510/02601BDA
  - Same microcircuit in an alternate package
  - Buyer requested expedited delivery schedule
- **Results**
  - New wafer lot was manufactured
  - Package assembly used new alternate package
  - Delivery was 17 weeks earlier than promised date
  - Shipment was 24 years after first product shipment and 17 years since the last delivery to DLA


1997: Initial design and manufacture

24 years later


2021: New wafer lot manufactured assembled in an alternate package

# Emulation Provides Multiple System Support

Bradley M2A2

F-22 Raptor

F-15 Eagle

C-17 Globemaster III

F/A-18 Hornet

**GEM34301QPA**
**SMD Part No: 5962-9052201PA**
**NSN: 5962-01-376-2175**

**Single GEM Microcircuit Used Across Several Systems Maintaining Readiness**

# Emulation Success Story
## Maintaining the F-15 Eagle

### History of GEM emulations

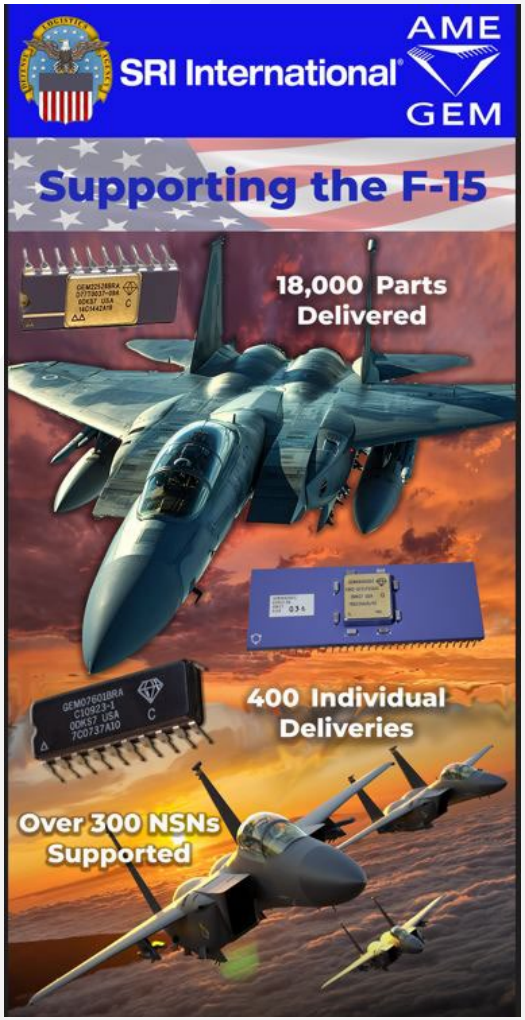
- First GEM microcircuits manufactured in 1997
- Over 18,000 parts delivered
- More than 400 delivery orders
- Delivered to Boeing, DLA Land & Maritime, and distributors for U. S. and FMS customers

### GEM Microcircuit National Stock Numbers

- Aircraft: 335 NSNs
- Simulators: 19 NSNs
- Support Equipment: 28 NSNs

### Benefit to U. S. Air Force and allies

- Keeps maintenance costs low
- Parts can be sourced through DLA
- Minimizes equipment down time
- Permanent solution to obsolescence



# Current DLA SMCR listings

- Total of 1,004 microcircuits listed
- Additional microcircuits in the process of being added
- All can be manufactured on an on-demand basis

**DEFENSE LOGISTICS AGENCY**
**DLA Land and Maritime**
**Standard Microcircuit Cross-Reference**

December 4, 2023 Home Logout | [-]

New SMCR Search

**Part Number / Key Word Search Results**

**Caution:** Do not use Vendor PN for item acquisition (procurement). Items acquired to this number may not satisfy the performance requirements of the Standard PN as specified in the SMD or MIL-M-38510 slash sheet.

**Vendor Name contains sri**

Previous 1 Next Total Records Received: 1004 25

| Standard PN | Source | Vendor PN | EOL Date | Description |
|---|---|---|---|---|
| 5962-0050701QEA | SRI | GEM22101QEA | | TIMER/COUNTER, PROGRAMMABLE |
| 5962-0050701QEC | SRI | GEM22101QEC | | TIMER/COUNTER, PROGRAMMABLE |
| 5962-0150701Q2A | SRI | GEM31701Q2A | | LOOK-AHEAD CARRY GENERATOR, HIGH SPEED |
| 5962-0150701Q2C | SRI | GEM31701Q2C | | LOOK-AHEAD CARRY GENERATOR, HIGH SPEED |
| 5962-0150701QEA | SRI | GEM31701QEA | | LOOK-AHEAD CARRY GENERATOR, HIGH SPEED |
| 5962-0150701QEC | SRI | GEM31701QEC | | LOOK-AHEAD CARRY GENERATOR, HIGH SPEED |
| 5962-0721701QXA | SRI | GEM36401QXA | | MICROPROCESSOR, 16-BIT, MIL-STD-1750A |
| 5962-0721701QXC | SRI | GEM36401QXC | | MICROPROCESSOR, 16-BIT, MIL-STD-1750A |
| 5962-0922201QEA | SRI | GEM40301QEA | | SYNCHRONOUS 4-BIT UP/DOWN BINARY COUNTER |
| 5962-8550102CA | SRI | GEM39202QCA | | HEX INVERTER, SCHMITT TRIGGER |
| 5962-8550102CC | SRI | GEM39202QCC | | HEX INVERTER, SCHMITT TRIGGER |
| 5962-86702012A | SRI | GEM07301Q2A | | REGISTER, D-TYPE, QUAD, WITH TWO INDEPENDENTLY-CONTROLLED 3-STATE OUTPUTS |

# GEM Part Search Website

## GEM Parts List

See your part? Request a quote.

Search: 596201

| Part Number | Generic P/N | GEM P/N | Description | Status | NSN |
|---|---|---|---|---|---|
| 5962-8754201RA | 25LS2513 | GEM02901BRA | PRIORITY ENCODER, 8-TO-3 LINE | Emulation Available | 5962012642962 |
| 5962-8754201SA | 25LS2513 | GEM02901BSA | PRIORITY ENCODER, 8-TO-3 LINE | Emulation Available | 5962012642963 |
| M38510/00601BDA | 5482 | GEM03601BDA | ADDER, 2-BIT | Emulation Available | 5962014675841 |
| 7702701CX | 4069UB | | GATE, INVERTER, HEX | Emulation Available | 5962011249258 |
| M38510/17401BCA | 4069UB | | GATE, INVERTER, HEX | Emulation Available | 5962011249258 |
| M38510/01308BEA | 54192 | GEM04601BEA | COUNTER, 4-BIT, UP/DOWN, SYNCHRONOUS, ASYNCHRONOUS RESET AND ENABLE | Emulation Available | 5962010203519 |
| SNJ54192J | 54192 | | COUNTER, 4-BIT, UP/DOWN, SYNCHRONOUS, ASYNCHRONOUS RESET AND ENABLE | Emulation Available | 5962014839882 |
| M38510/31507BEA | 54LS192 | | COUNTER, 4-BIT, UP/DOWN, SYNCHRONOUS, ASYNCHRONOUS RESET AND ENABLE | Emulation Available | 5962010689592 |
| M38510/31507BFA | 54LS192 | GEM05101BFA | COUNTER, 4-BIT, UP/DOWN, SYNCHRONOUS, ASYNCHRONOUS RESET AND ENABLE | Emulation Available | 5962010705871 |
| M38510/02201BCA | 54H72 | GEM05901BCA | FLIP-FLOP, JK, PRESET, CLEAR, SINGLE | Emulation Available | 5962010195476 |
| M38510/02601BAA | 54L86 | GEM06001BAA | GATE, EXCLUSIVE-OR, QUAD | Emulation Available | 5962014239501 |
| 5962-8689001CA | 54HCT14 | GEM06301QCA | GATE, INVERTER, TTL-COMPATIBLE INPUTS, HEX | Emulation Available | 5962012583494 |
| M38510/65752BCA | 54HCT14 | GEM06352BCA | GATE, INVERTER, TTL-COMPATIBLE INPUTS, HEX | Emulation Available | 5962014334908 |
| SNJ54HCT14J | 54HCT14 | | GATE, INVERTER, TTL-COMPATIBLE INPUTS, HEX | Emulation Available | 5962012583494 |
| M38510/01504BEA | 9314 | GEM06401BEA | LATCH, 4-BIT, MASTER RESET | Emulation Available | 5962010262494 |
| M38510/07501BDA | 54S86 | | GATE, EXCLUSIVE-OR, QUAD | Emulation Available | 5962012862904 |
| M38510/02002BCA | 54L20 | GEM06701BCA | GATE, NAND, DUAL | Emulation Available | 5962012686365 |
| M38510/02002BDA | 54L20 | GEM06701BDA | GATE, NAND, DUAL | Emulation Available | 5962012859153 |
| 7700703QA | 2901 | GEM06803QQA | MICROPROCESSOR, 4-BIT | Emulation Available | 5962014659391 |
| 8405701QA | 2901C | GEM06801QQA | MICROPROCESSOR, SLICE, 4-BIT | Emulation Available | 5962012251555 |
| 8405701ZA | 2901C | GEM06801QZA | MICROPROCESSOR, SLICE, 4-BIT | Emulation Available | 5962012134583 |
| M38510/02501BCA | 54L90 | GEM06901BCA | COUNTER, 4-BIT, BINARY | Emulation Available | 5962010900727 |
| 5962-8670201RA | 25LS2519 | GEM07301QRA | REGISTER, D-TYPE, TWO INDEPENDENTLY-CONTROL | Emulation Available | 5962012527009 |
| M38510/23104BEA | 93L425 | GEM07401BEA | MEMORY, RAM, STATIC, LOW-POWER, 70NS ACCESS | Emulation Available | 5962011092430 |
| 5962-8672301RA | 2947 | GEM07501QRA | TRANSCEIVER, 8-BIT, 3-STATE OUTPUTS | Emulation Available | 5962012537436 |
| Part Number | Generic ... | GEM P/N | Description | Status | NSN |

## Search for parts and download the existing list

- Over 30,000 parts currently listed @ gemes.com/parts/
- Search by part, generic, or GEM part numbers, description, or NSN
- Updated when newly emulated parts or a new technology becomes available

# Cost of Emulation

- **Non-Reoccurring Engineering Costs**
  - NRE costs are reviewed by DLA
  - DLA determines the amount of NRE funding
  - Unique applications may be jointly funded
  - Non-funded NRE costs are added to the unit price of the initial parts order
- **Prototype and production devices**
  - Part prices are set by DLA
  - Purchasing organization responsible for part costs
- **Insertion testing costs**
  - Funded by weapon system program office or contractor

# How to Obtain GEM Parts

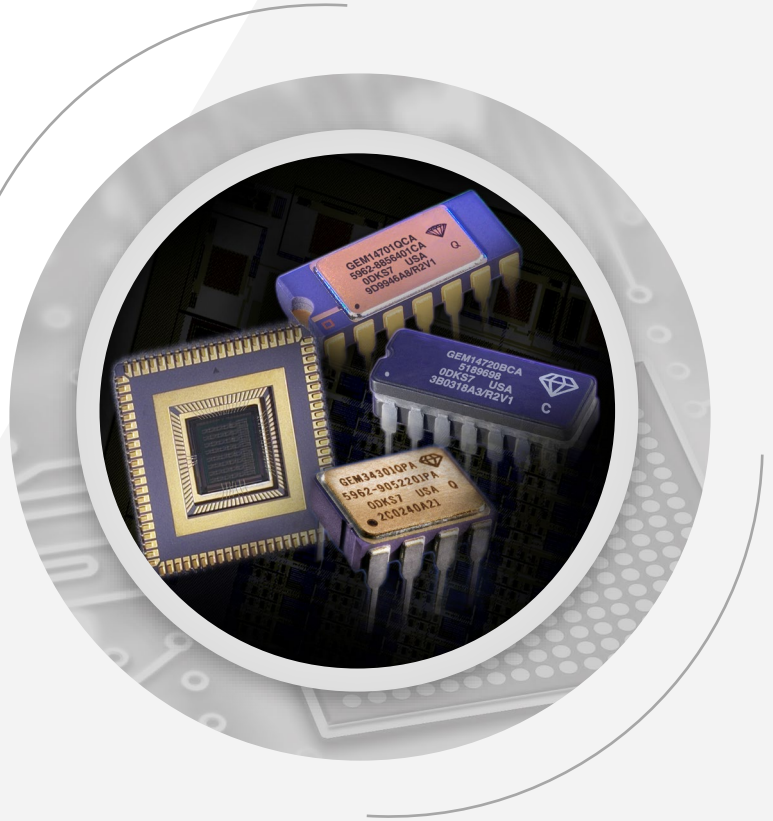
**Through Direct Contract with SRI**

- Applies to Government, Non-Government, & Commercial Activities
- Contract Arrangement through SRI and the Customer

**Through DLA logistic channels**

- Requisitions to DLA
- Military Service (MILSVC) funded requirements
- Military Interdepartmental Purchase Request (MIPR) to DLA
- SOW/RFP Prepared and Coordinated by DLA

**DLA verifies no alternative commercial source is available**



## Who *Can Purchase GEM Devices?*

All Military Services, All Government and Federal Agencies, Original End Equipment Manufacturers and Distributors

# Generalized Emulation of Microcircuits

- GEM Breaks the Obsolescence Cycle
- Over 560 weapon systems supported
- Over 175,000 QML qualified parts delivered
- Over 1000 parts listed on DLA QML–38535
- Capability to manufacture over 30,000 parts


## GEM Benefits

- Over $2B estimated cost avoidance
- Eliminate counterfeit concerns
- Avert MICAP & production shutdowns
- Maintain weapon system readiness levels
- Support the warfighter with a cost-effective, permanent, long-term solution

*Visit*
*SRI International at*
*Booth No. 309*

 www.gemes.com