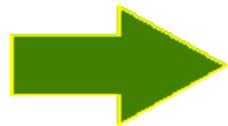




**POSIX REAL-TIME DISTRIBUTED  
SYSTEMS COMMUNICATION**  
**Open Systems-Joint Task Force**  
**WALCOFF AUDITORIUM**  
**29 May 1996**  
**FAIRFAX VA**

**JOHN BRENNAN**  
**NUWC, NEWPORT, COMBAT SYSTEMS**  
**DIANE PAUL**  
**TEXAS INSTRUMENTS, SYSTEMS**  
**GROUP**  
**B. CRAIG MEYERS**  
**SOFTWARE ENGINEERING INSTITUTE**



## **BACKGROUND (AGENT BRIEFS)**

- **TECHNICAL DETAILS**
- **CONTRACTING/FINANCIAL/ISSUES**
- **FY97 RECOMMENDATIONS**
- **SUMMARY**



## GENERAL PROBLEM:

- Embedded Systems unaffordable because:
  - Proprietary systems limit potential sources and do not leverage industry-funded advances
  - Application software not isolated from underlying hardware
- Result is expensive development, production, and support

## SOLUTION:

- Develop a set of standardized interfaces for real-time distributed communications facilities to support application portability at the source-code level
- Allows commercial vendors to build open systems components and DoD to build systems using them
- Result is more **affordable** systems

## BENEFICIARIES:

- Joint Strike Fighter



# PROJECT OVERVIEW



- **JOINT EFFORT OF GOVERNMENT, INDUSTRY, AND ACADEMIA TO PROVIDE APIS TO SATISFY A WIDE RANGE OF REAL-TIME APPLICATIONS**
- **INCORPORATION OF REAL-TIME FEATURES, SUCH AS MESSAGE PRIORITIES, BUFFER MANAGEMENT, AND ASYNCHRONOUS INTERACTIONS**
- **INCORPORATION OF COMMUNICATIONS MODELS BEYOND P1003.1G, INCLUDING UNICAST, MULTICAST, BROADCAST, AND MESSAGE TYPES**
- **ABILITY TO UTILIZE FASTER AND BETTER PROTOCOLS AS THEY ARE DEVELOPED**



## TEXAS INSTRUMENTS, INC (TI) HAS:

- **PROTOTYPED AND DEMONSTRATED A SUBSET OF THE IEEE 1003.21 POSIX APIS FOR REAL-TIME DISTRIBUTED SYSTEMS COMMUNICATION IN ADA**
- **SHOWN FEASIBILITY OF USING STANDARD POSIX API IN EMBEDDED SYSTEMS USING F-22 PROTOTYPE MISSION DISPLAY PROCESSOR**
- **QUANTIFIED OVERHEAD OF STANDARD API VS. TI PROPRIETARY API**



- **BACKGROUND**



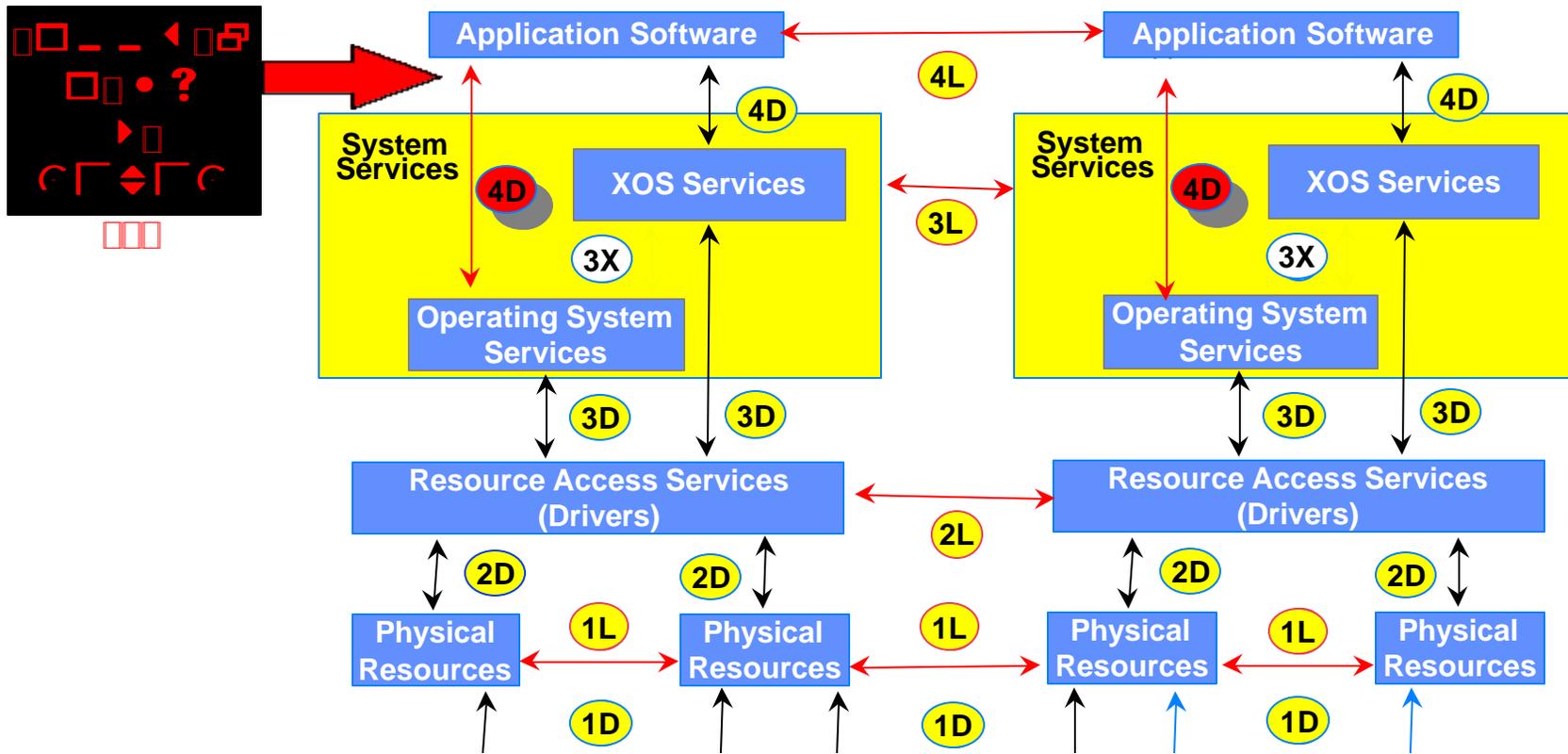
- **TECHNICAL DETAILS**

- **CONTRACTING/FINANCIAL/ISSUES**

- **FY97 RECOMMENDATIONS**

- **SUMMARY**

# P1003.21 and the Generic Open Architecture Model

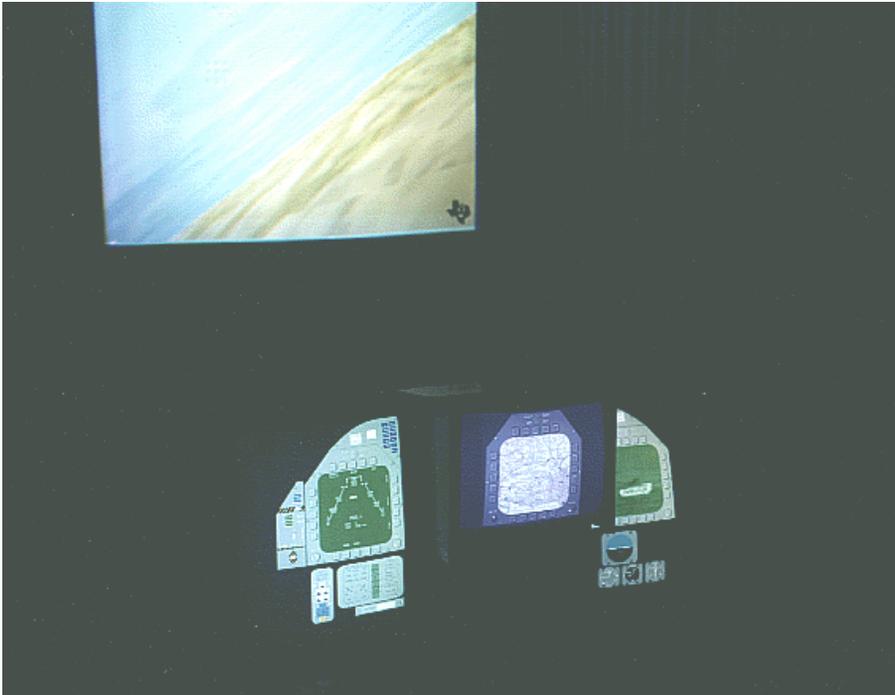


- |    |   |    |   |
|----|---|----|---|
| 4L | Applications Logical Peer IFs                           | 2L | Resource Access Services Logical Peer IFs           |
| 4D | Applications-to-System Services Direct IFs              | 2D | Resource Access Serv.-to-Phys. Resources Direct IFs |
| 3L | System Services Logical Peer IFs                        | 1L | Physical Resources Logical Peer IFs                 |
| 3D | Sys. Services SW-to-Resource Access Services Direct IFs | 1D | Physical Resources-to-Physical Resources Direct IFs |
| 3X | OS Services-to-XOS Services Direct IFs                  |    |   |

# DEMONSTRATION ENVIRONMENT



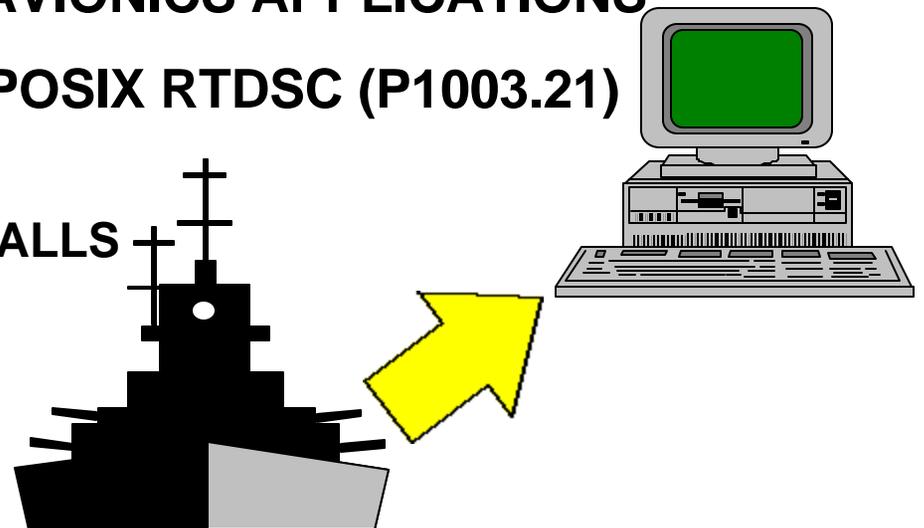
Prototyping/  
Simulation



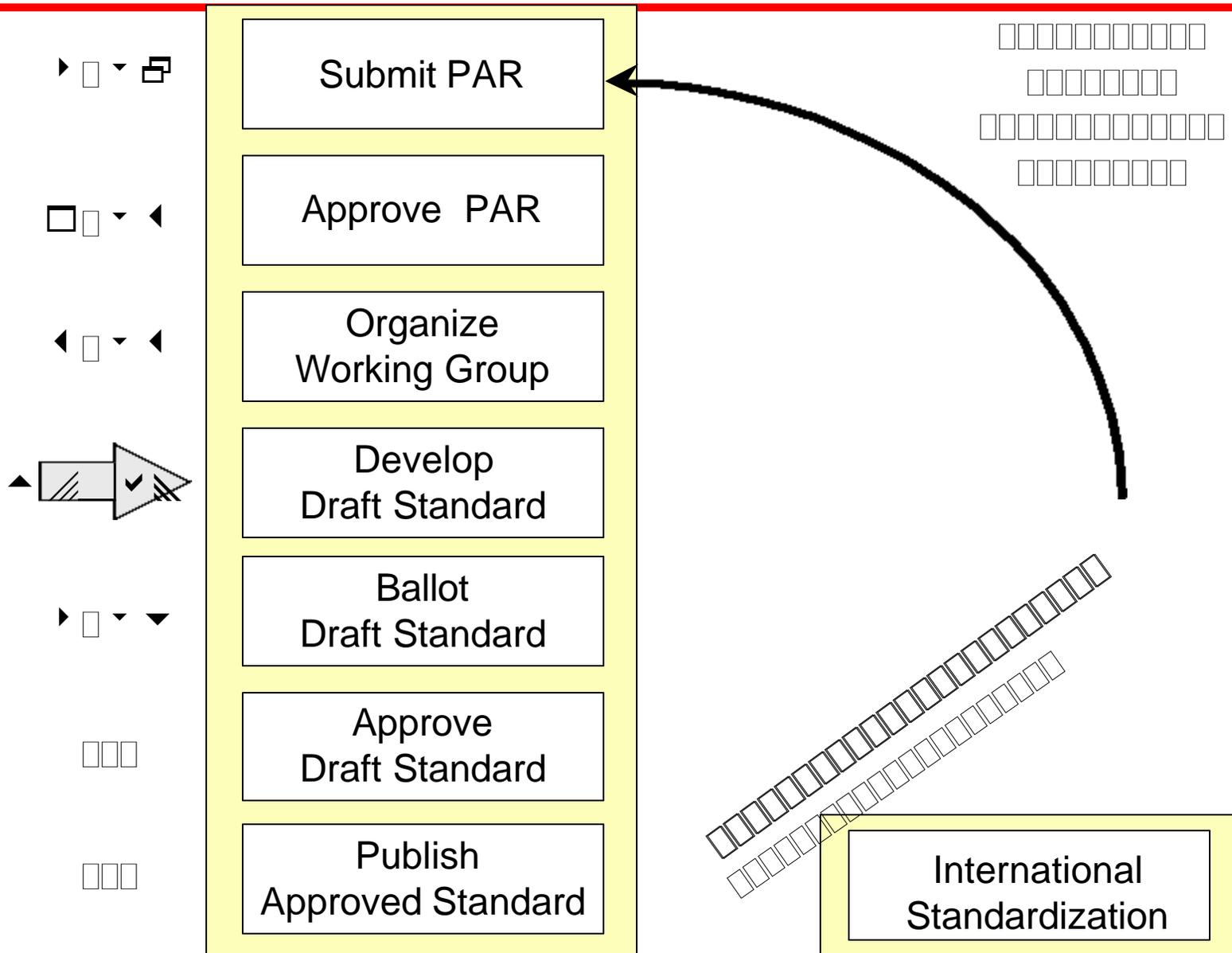
# DEMONSTRATION ENVIRONMENT



- **MISSION DISPLAY PROCESSOR USED IN YF22 PROTOTYPE**
  - THREE MIL-STD-1750A BASED DATA PROCESSOR MODULES
  - MIL-STD-1553B INTERFACE TO TI F-18 COCKPIT SIMULATOR
- **TI RECONFIGURABLE OPERATING SYSTEM AS BASELINE**
- **TARTAN Ada83 COMPILER**
- **FOUR “REPRESENTATIVE” AVIONICS APPLICATIONS**
- **PROTOTYPING SUBSET OF POSIX RTDSC (P1003.21)**
  - MESSAGE TYPES MODEL
  - 23 OUT OF 109 FUNCTION CALLS



# STANDARDIZATION PROCESS & STATUS (IEEE)



# ORGANIZATIONS REPRESENTED IN P1003.21



- **Software Engineering Institute, Carnegie-Mellon University**
- **Naval Undersea Warfare Center, Newport**
- **Texas Instruments, Inc.**
- **Lockheed-Martin**



- **BACKGROUND (AGENT BRIEFS)**
- **TECHNICAL DETAILS**
-  **CONTRACTING/FINANCIAL/ISSUES**
- **FY97 RECOMMENDATIONS**
- **SUMMARY**

# CONTRACTS



## TYPE OF CONTRACT:

- FFP TASK ADDED TO DYNAMIC RECONFIGURATION DEMO SYSTEM (DRDS) CONTRACT
- FFP SOLE SOURCE CONTRACT TO CONTINUE EFFORT

## PERIOD OF PERFORMANCE:

- 02/95 - 12/96

## STATUS AS OF 5/29/96:

- INITIAL PROTOTYPE OF MESSAGE TYPES MODEL COMPLETED
- SOLE SOURCE CONTRACT FOR ADDITIONAL SUPPORT IN NEGOTIATION

## RETURN ON INVESTMENT:

- DEVELOPMENT
- PRODUCTION
- SUPPORT/MAINTENANCE

## CONTRACT & ADMINISTRATOR:

- DRDS Contract # N00163-91-C-95-0226
- Diane Kohalmi  
(317) 306-3799  
kohalmd@po1.nawc-ad-indy.navy.mil  
Naval Air Warfare Center, Aircraft Division  
6000 East 21st Street  
Indianapolis, IN 46219-2189

## CONTRACT VALUE:

- FY95: \$147K
- FY96: \$262K

## OTHER CONTRIBUTIONS:

- NAWC DRDS PROGRAM, \$260K
- TI IR&D, \$1M+

## DELIVERABLES:

- TECHNICAL REPORT

# ISSUES



- **FY96 FUNDS ALLOCATED, BUT SOLE SOURCE CONTRACT STILL IN WORK**
- **P1003.21 SHOULD BE TAILORED TO:**
  - ELIMINATE SOME FUNCTIONS
  - COMBINE SOME MODELS
  - INTEGRATE WITH REST OF P1003.x
- **COTS SUPPORT OF P1003.21**
- **CONTINUED COTS SUPPORT FOR LIFE OF WEAPON SYSTEM**



- **BACKGROUND (AGENT BRIEFS)**
- **TECHNICAL DETAILS**
- **CONTRACTING/FINANCIAL/ISSUES**
-  **FY97 RECOMMENDATIONS**
- **SUMMARY**

# PROJECT SCHEDULE

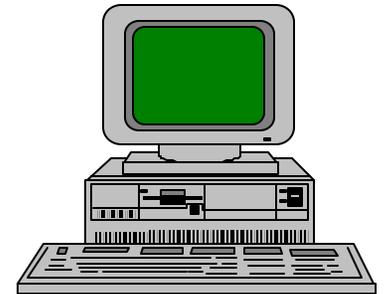


ID	Task Name	1997												1998											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	DRDS Port to COTS Tes																								
2	DRDS PORT to Ada95																								
3	P1003.21 Avionic Profi																								
4	IEEE P1003 July '96 Me																								
5	IEEE P1003 Oct '96 Me																								
6	IEEE P1003 Jan '97 Me																								
7	IEEE P1003 Apr '97 Me																								
8	IEEE P1003 July '97 Me																								
9	IEEE P1003 Oct '97 Me																								
10	IEEE P1003 Jan '98 Me																								
11	IEEE P1003 Apr '98 Me																								
12	IEEE P1003 July '98 Me																								
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# FY97 RECOMMENDATIONS (1)



- **TAILOR P1003.21**
  - COMBINE SOME MODELS
  - ELIMINATE SOME FUNCTIONS
  - INTEGRATE WITH REST OF P1003.x
- **PROTOTYPE OTHER P1003.21 MODELS**
- **DETERMINE P1003.21 AVIONICS PROFILE**



# FY97 RECOMMENDATIONS (2)



- **JOHN BRENNAN**
  - CONTINUE AS P1003.21 TECHNICAL EDITOR
  - DEVELOPMENT OF P1003.21 ADA BINDING
  - NAVY PROJECTS (NGCR, NSSN, BSY/2, etc.)
  
- **TI**
  - CONTINUE INVOLVEMENT IN P1003.21
  - ENSURE PROTOTYPE TRACKS STANDARD AS IT EVOLVES

# OUTLINE



- **BACKGROUND (AGENT BRIEFS)**
- **TECHNICAL DETAILS**
- **CONTRACTING/FINANCIAL/ISSUES**
- **FY97 RECOMMENDATIONS**
- ➔ **SUMMARY**

# SUMMARY



- **TI HAS LONG HISTORY OF SUPPORTING OPEN SYSTEMS VIA POSIX AND SAE PARTICIPATION**
- **STANDARDIZATION OF REAL-TIME DISTRIBUTED COMMUNICATION INTERFACE FACILITATES PORTABILITY OF APPLICATION SOFTWARE - **KEY TO AFFORDABILITY****
- **STANDARDIZATION ALLOWS MORE RE-USE OF APPLICATION SOFTWARE**
- **PROTOTYPING & SIMULATION OF PROPOSED POSIX INTERFACE STANDARD SUPPLEMENTED WITH MILITARY REQUIREMENTS WILL ACCELERATE DEVELOPMENT AND BALLOTING OF P1003.21**
- **CONSISTENT FUNDING AND SUPPORT THROUGH FY99 REQUIRED TO PUBLISH INTERNATIONAL STANDARD**

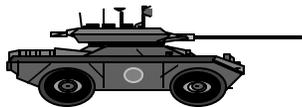
# BACKUPS

# APPLICABLE TECHNOLOGY (FUTURE AFFORDABILITY)



## Surface Combatant for the 21st Century

- Cooperative Engagement System
- GCCS/IFF/MIDS Antenna & Processors



## M1A1 Vetrionics Pre-Planned Product Improvement

- Add GCCS/IFF/MIDS Antenna & Processors

## Crusader Mobil Gun

- Weapons Solution Computer

## Arsenal Ship

- Ship Control

## Joint Strike Fighter

- Integrated Core Processor

## Dark Star UAV Tier III-

- Sensor Collection & Distribution System

# CORPORATE & GOVERNMENT INVOLVEMENT (WORKING GROUP MEMBERS PROMOTING STD)

- **CHAIR**
  - B. Craig Meyer, SEI
- **VICE-CHAIR**
  - Shirley Bockstahler-Brandt, JHUAPL
- **SECRETARY**
  - Kari Kruemple, Unisys
- **TECHNICAL EDITOR**
  - John Brennan, NUWC, Newport
  - Bill Pollak, SEI
- **BALLOT COORDINATOR**
  - TBD
- **INTERNATIONAL STANDARDS LIAISON**
  - TBD

Submit PAR

Approve PAR

Organize  
Working Group

Develop  
Draft Standard

Ballot  
Draft Standard

Approve  
Draft Standard

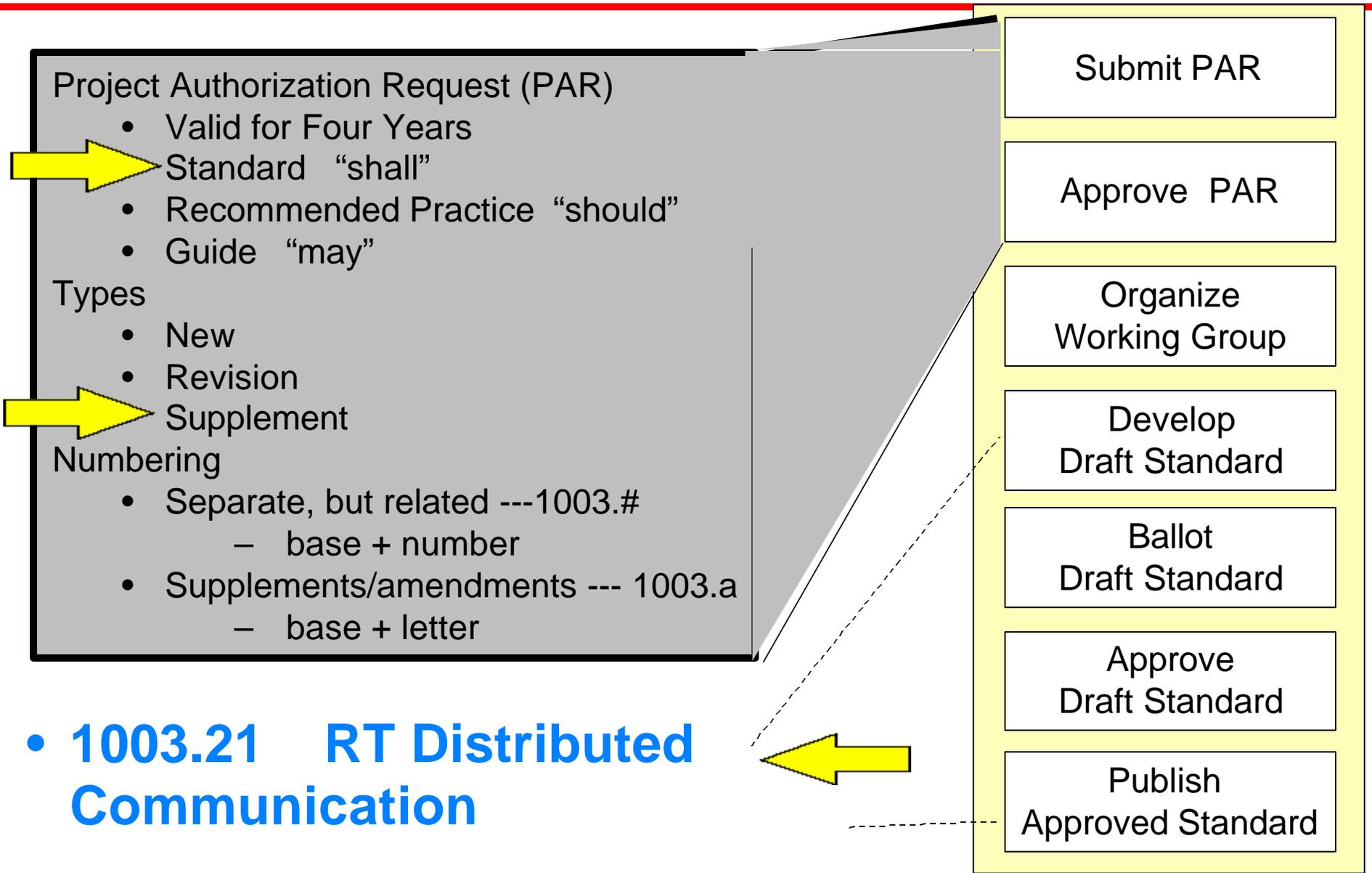
Publish  
Approved Standard

# BENEFICIARY POINTS OF CONTACT



- 
- Dynamic Reconfiguration Demonstration System (DRDS)
    - Diane Kohalmi
    - 317-306-3799
    - kohalmd@po1.nawc-ad-indy.navy.mil
    - 6000 East 21st  
Indianapolis, IN 46219-2189
  - Dynamic Reconfiguration Demonstration System (DRDS)
    - Diane Paul
    - 214-575-2787
    - diane-paul@ti.com
    - 6600 Chase Oaks Blvd.  
M/S 8489  
Plano, TX 75023
  - P1003.21 Working Group Technical Editor
    - John Brennan
    - 401-841-4581
    - brennan@code22.npt.nuwc.navy.mil
    - Naval Undersea Warfare Center Division Newport
    - Code 2253, Bldg. 1171/2
    - Newport, RI 02841

# UNDERSTANDING IEEE STANDARDIZATION



# IEEE 1003.21 RTDSC CATEGORIES

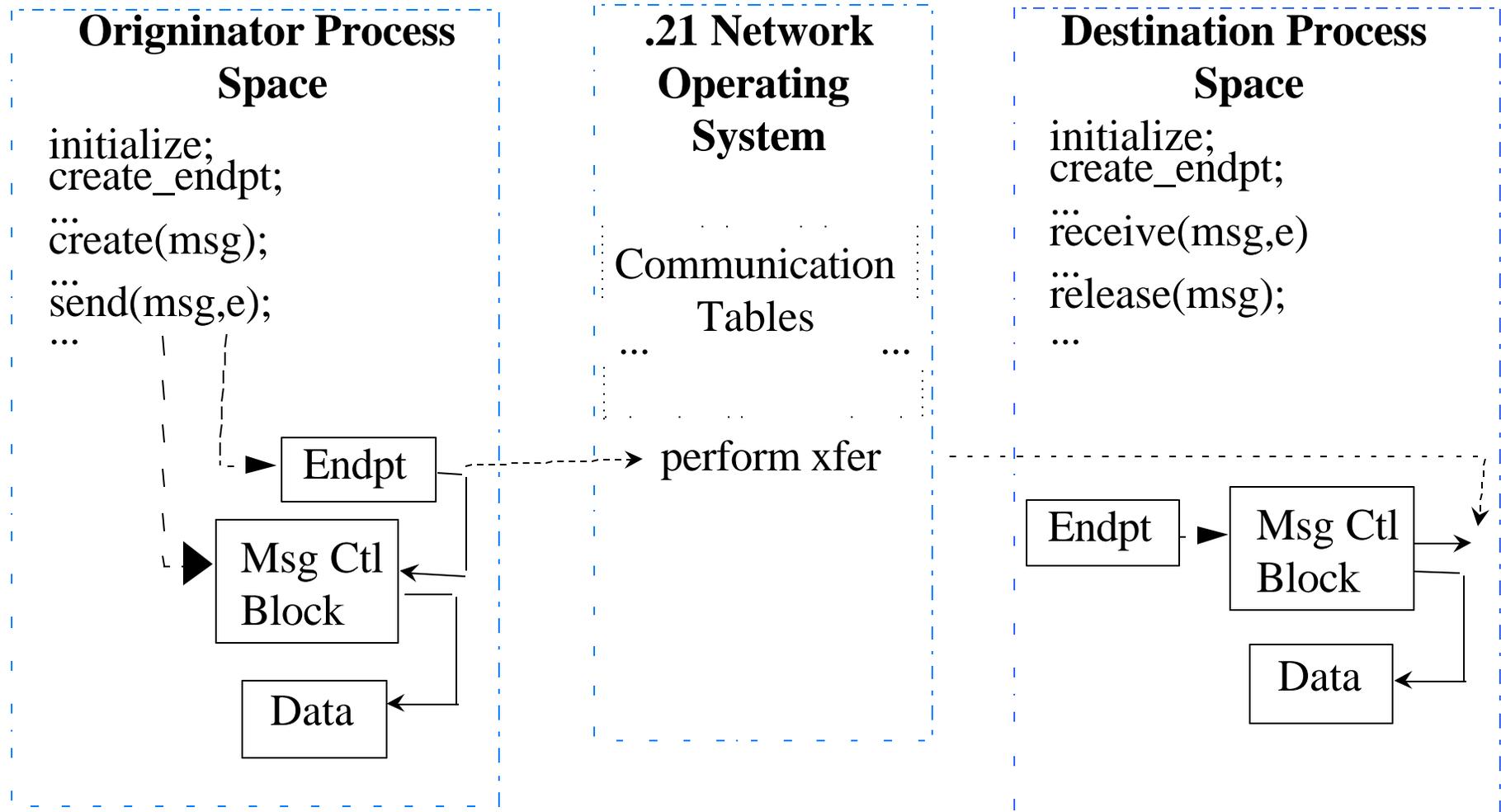


- **System Identification**
- **Initialization**
- **Asynchronous Operations**
- **Buffer Management**
- **Endpoint Management**
- **Directory Services**
- **General Data Transfer**
- **Unicast**
- **Broadcast**
- **Event Management**
- **Protocol Management**
- **Message Types**
- **Multicast Groups**
- **Heterogeneity**
- **Performance Measurement**
- **Connection Management**
- **Termination**



- 
- **Sending Messages from Endpoint to Endpoint**
  - **Endpoints May be Shared Among Threads in a Process**
  - **Buffer Management allows Application Control of Memory Allocation**
  - **Supports Distributed Heterogenous Systems**

# P1003.21 MESSAGE TYPES MODEL



# P1003.21 PROTOTYPE



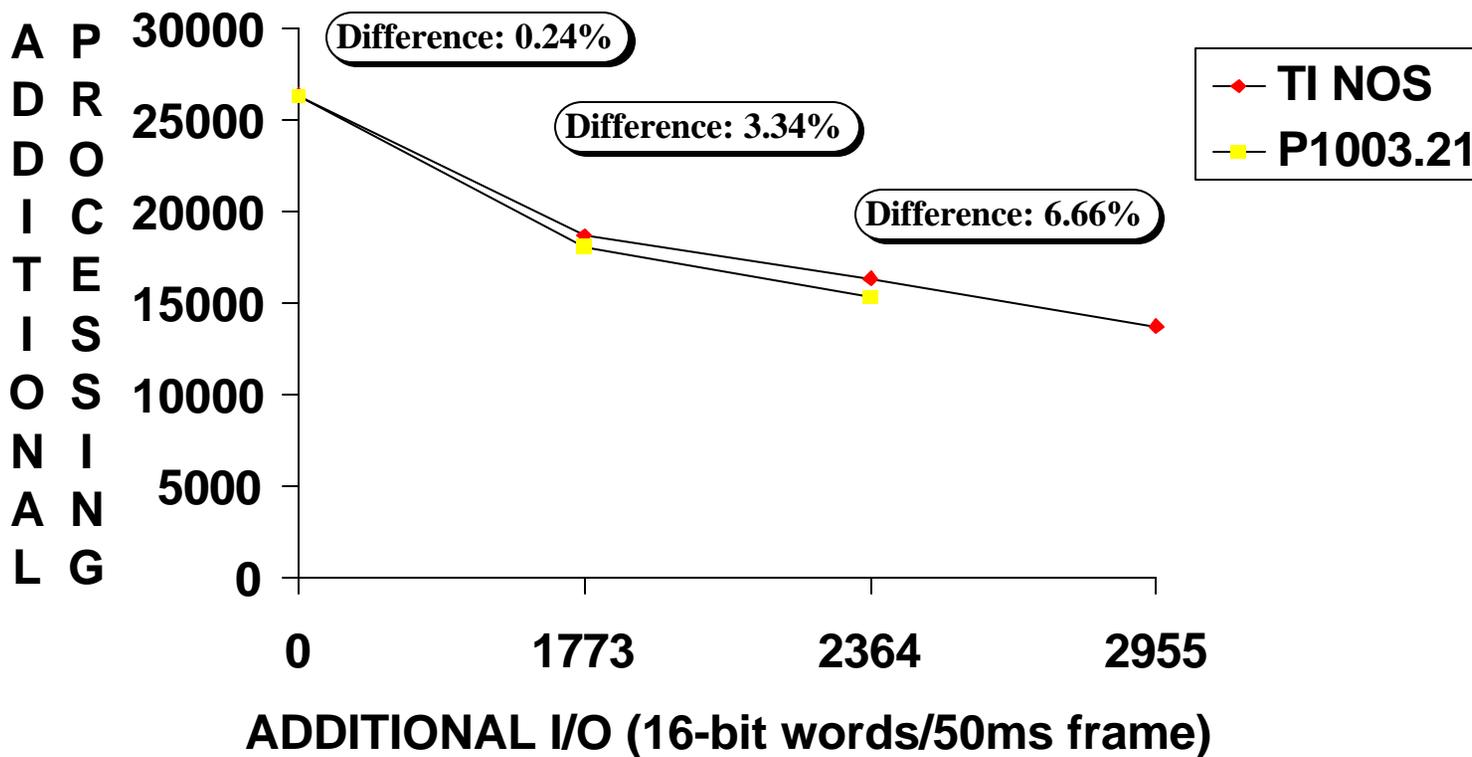
- **Objective: Support critical JAST milestones:**
  - Selection of JAST core processor operating system
  - Demonstrate operating system concepts
- **Approach:**
  - Prototyped subset of P1003.21 API using TI Reconfigurable Network Operating System (NOS) as the underlying protocol
  - Chose subset that (1) performs basic message passing and (2) contains operations analogous to TI NOS operations
  - Collected timing and memory size measurements at the system level, as well as for individual operations, for both P1003.21 and TI NOS implementations

# P1003.21 PROTOTYPE, cont.

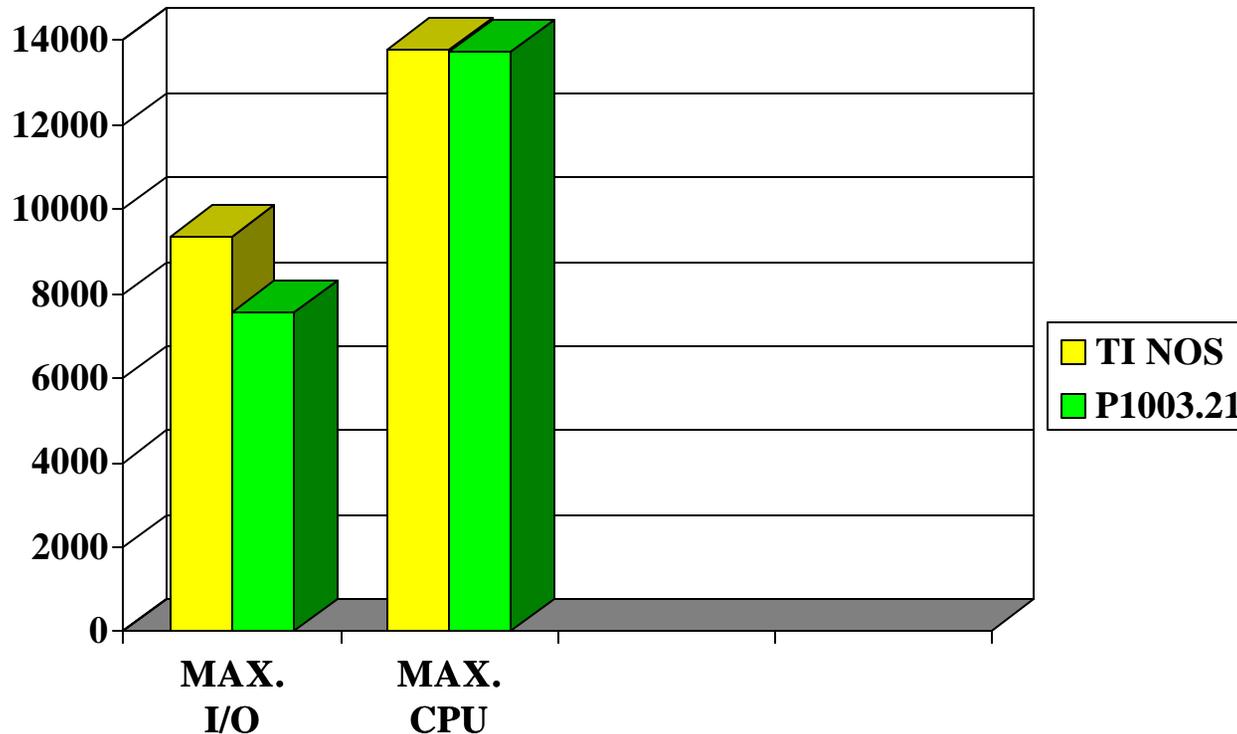


- **Outputs:**
  - **Measurements to assist in determining POSIX applicability to next generation real-time avionics computing performance requirements**
  - **Measurements will also provide feedback to IEEE P1003.21 working group to fine-tune development of specification**
  - **Recommendations for tailoring P1003.21 for real-time avionics systems**

# EMBEDDED COMPUTER PERFORMANCE MEASUREMENT (ECPM)

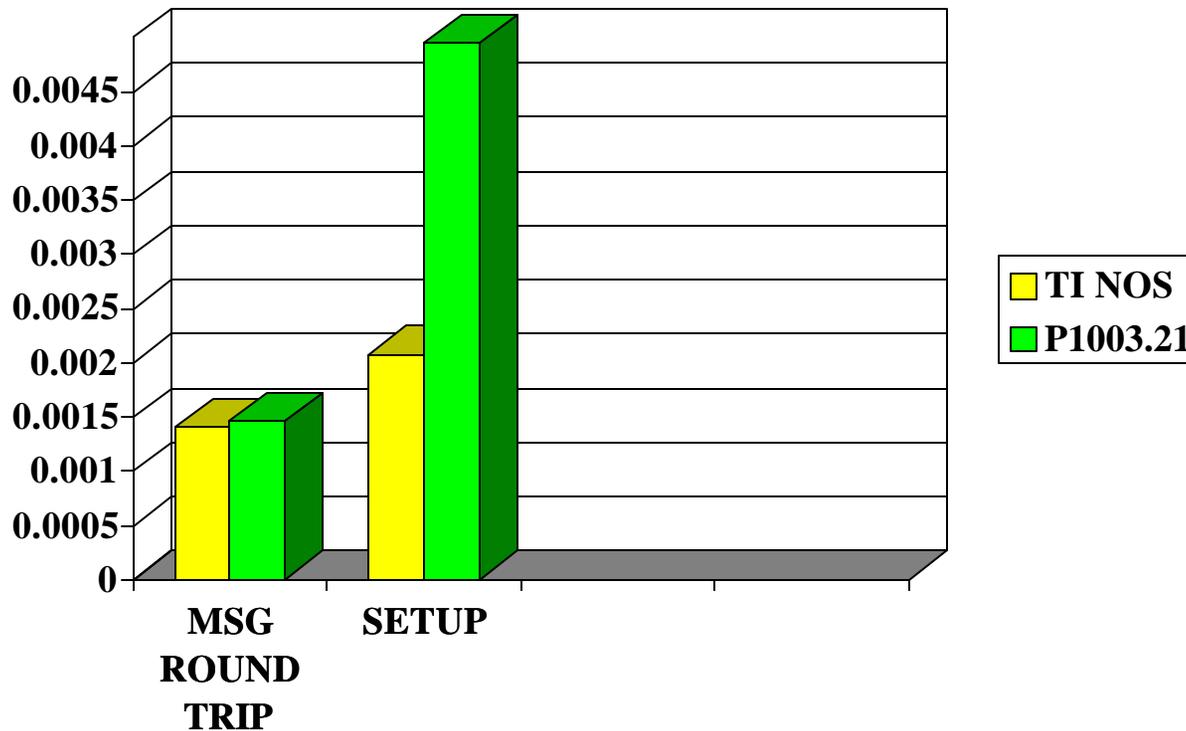


# ECPM MAXIMUM I/O AND PROCESSING MEASUREMENTS



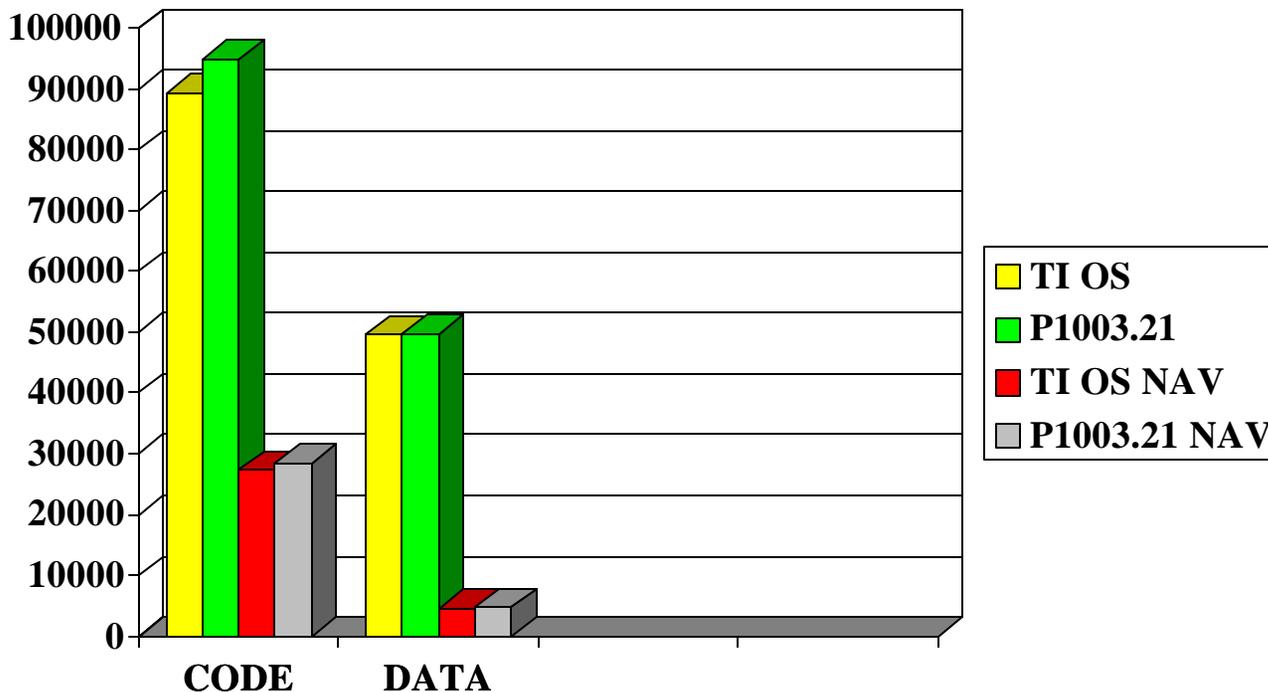
- I/O throughput performance difference between TI NOS and P1003.21 NOS approximately 23.50%
- CPU throughput performance difference between TI NOS and P1003.21 NOS approximately 0.16%

# INDIVIDUAL OPERATION TIMING MEASUREMENTS (IN SECONDS)



- Average difference between TI NOS and P1003.21 NOS message round-trip time: 4.76%
- Average difference between TI NOS and P1003.21 NOS setup time: 183%

# STATIC MEMORY SIZE (BYTES)



- Difference between TI NOS and P1003.21 OS code size: 5.26%
- Difference between TI NOS and P1003.21 OS data size: 0.28%
- Difference between TI NOS and P1003.21 NAV code size: 4.21%
- Difference between TI NOS and P1003.21 NAV data size: 3.81%

# CONCLUSIONS



- **Real-Time avionics systems do not require all procedure calls currently specified in P1003.21**
- **P1003.21 API does not add a large amount of overhead**
- **Quality of API implementation is greatest factor in performance and sizing measurements**
- **Additional experiments recommended**
  - **Prototype other P1003.21 communication models**
  - **Port DRDS to open system testbed with COTS hardware and software**
  - **Port DRDS to Ada95**



- **Continue P1003.21 participation**
- **Update prototype API as Language Independent Specification evolves**
- **Provide prototype package specifications as input when P1003.21 Ada bindings subcommittee is formed**

# DRDS PROJECT SCHEDULE



ID	Task Name	Durat	1991	1992	1993	1994	1995	1996	1997	Qtr	
1	DRDS Contract	1388d		[Gantt bar spanning from start of 1992 to end of 1996]							
2	NAWC Contract Award to T	0d		9/6							
3	Phase 1	170d		[Blue bar]							
4	Phase 2 (Original Tasks)	1027d		[Gantt bar spanning from start of 1992 to end of 1995]							
5	JAST/POSIX Enhance	336d					[Blue bar]				
6	Contract Extension fo	0d		4/23							
7	Contract Extension fo	0d			12/17						
8	OS-JTF Additional Tasks	179d						[Gantt bar spanning from start of 1996 to end of 1996]			
9	OS-JTF FUNDING AF	0d						4/25			
10	Contract Extension fo	0d						5/24			
11	CRB and Legal Appro	6d						[Blue bar]			
12	Final Contract Negoti	6d						[Blue bar]			
13	Phase 3 Option Award	0d						6/14			
14	Phase 3 (Additional P	146d						[Blue bar]			
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23											

# ORGANIZATION OVERVIEW



- Texas Instruments, Inc (TI) HQ is located in Dallas, TX
- Work will be performed at Plano, TX Spring Creek facility
- NAWCAD, Indianapolis, Administers Contract