Use of RT CORBA by the U.S. Army

ISORC 2001, May 2, 2001
Session 5A

Ed Shrum

The MITRE Corporation

Eatontown, NJ, USA

Outline

- **Discussion of various Distributing Computing Technologies**
- **Why Real Time CORBA?**
- **Performance of DCE, RMI, CORBA and RT CORBA**
- **Military users of CORBA**
- **How Maneuver Control System (MCS) Uses RT CORBA (TAO)**
  - **Performance measurements: CORBA vs. non-CORBA**
- **PDA Prototype Architecture for Command & Control Systems**

What Are the Benefits of Object Technology (OT) and Reuse?

Surveys of ~40 projects at a major US telecommunications company showed that the use of OT resulted in:

~15% development cost savings per project in 1995, average 2 month savings in schedule. By 1998, these numbers had improved by 2x.

- **Some projects achieved 75-80% reuse on product families!**
- **One project developed ~23 Function Points/staff mo.!**

We are here to save money and to

solve problems that were impossible to solve before now.

What is Distributed Computing? Why is the US Army Interested?

- **A Distributed System consists of multiple executables interacting with each other over a network.**

- **Why use Distributed Computing?**
  - **Geographically diverse locations.**
  - **Several small machines are cheaper than one large one.**
  - **Replication of functionality in mission-critical applications.**
  - **As capacity is exceeded, more machines can be added.**

Comparison of DC Technologies

Technology	Status	OS	Lang	Pros	Cons
DCE	CCITT v1 1988	Unix PC	C/C++	First DC technology.	No longer supported by DII-COE.
Java/RMI	Java 1.1 1997	All	JAVA Only	Simple. Part of Java language.	No services. Language specific.
Jini	Java 1.2 1999	Most JVMs	JAVA Only	Discovery. Leasing.	New: Vendor support? Scalable? Security?
OpenWings	Alpha 1Q2001	All	(Any) Default Jini	C2 Support. Very flexible.	Vender specific. Not a product yet.
COM/DCOM/ DNA	COM 1993 DCOM1995 DNA 1999	PC	VB, C/C++	Largest user base.	Vender specific. Superseded by .Net
Microsoft .Net	VS.Net beta 3Q2000	PC	VB, C/C++ C#	Services based. Excellent potential.	Vender specific. Design not finalized.
CORBA	CORBA 1.0 1993	All	All	Large user base. Many vendors. Services & Facilities. Netscape support.	No Discovery or Leasing. No memory mgt.

Interoperability Among Distributed Computing Technologies

- **Bridges**
- **IIOP - Internet Inter-Operability Protocol**
- **SOAP- Simple Object Access Protocol**
- **RogueWave's Zorba: XML -> CORBA converter**
- **Others will follow!**

Summary of Distributed Computing Options and Component Models

Computing Environment	Component Model	Distributed Options
Windows	Active X	COM/DCOM/DNA, CORBA
JAVA (Windows & Unix)	JavaBeans	Java/RMI, Jini, CORBA
Hetrogeneous (Windows & Unix, C++ & JAVA)	**CORBA**	**CORBA**

Future: no one winner, but integration of all

Why Real Time CORBA?

- **Quality of Service (QoS)**
- **Predictable Response Times**
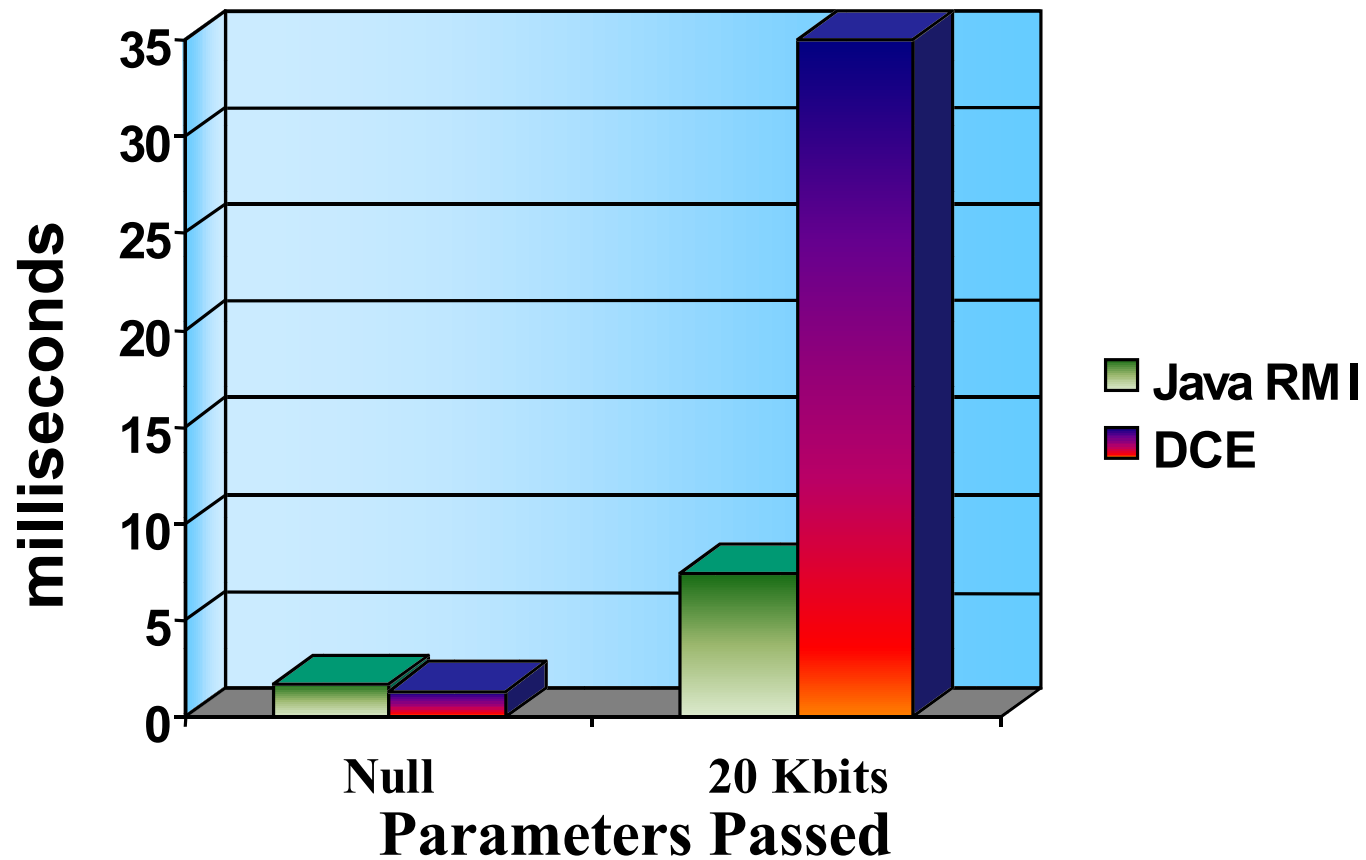- **Much Smaller Footprint**
- **Much Better Performance**

Real Time ORB Sizes

	Library Size	Stub Size
TAO	**~ 1 mbytes**	**1000 bytes**
ORBExpress	**~100 kbytes**	**300 bytes**

DCE vs RMI Performance

Non-Real Time ORB Performance

Java R M I

V isi Br oker
(V i sigen ics)

Java I D L (SU N
or b)

**Note: VisiBroker is
~ 2X faster than
IONA's Orbix**
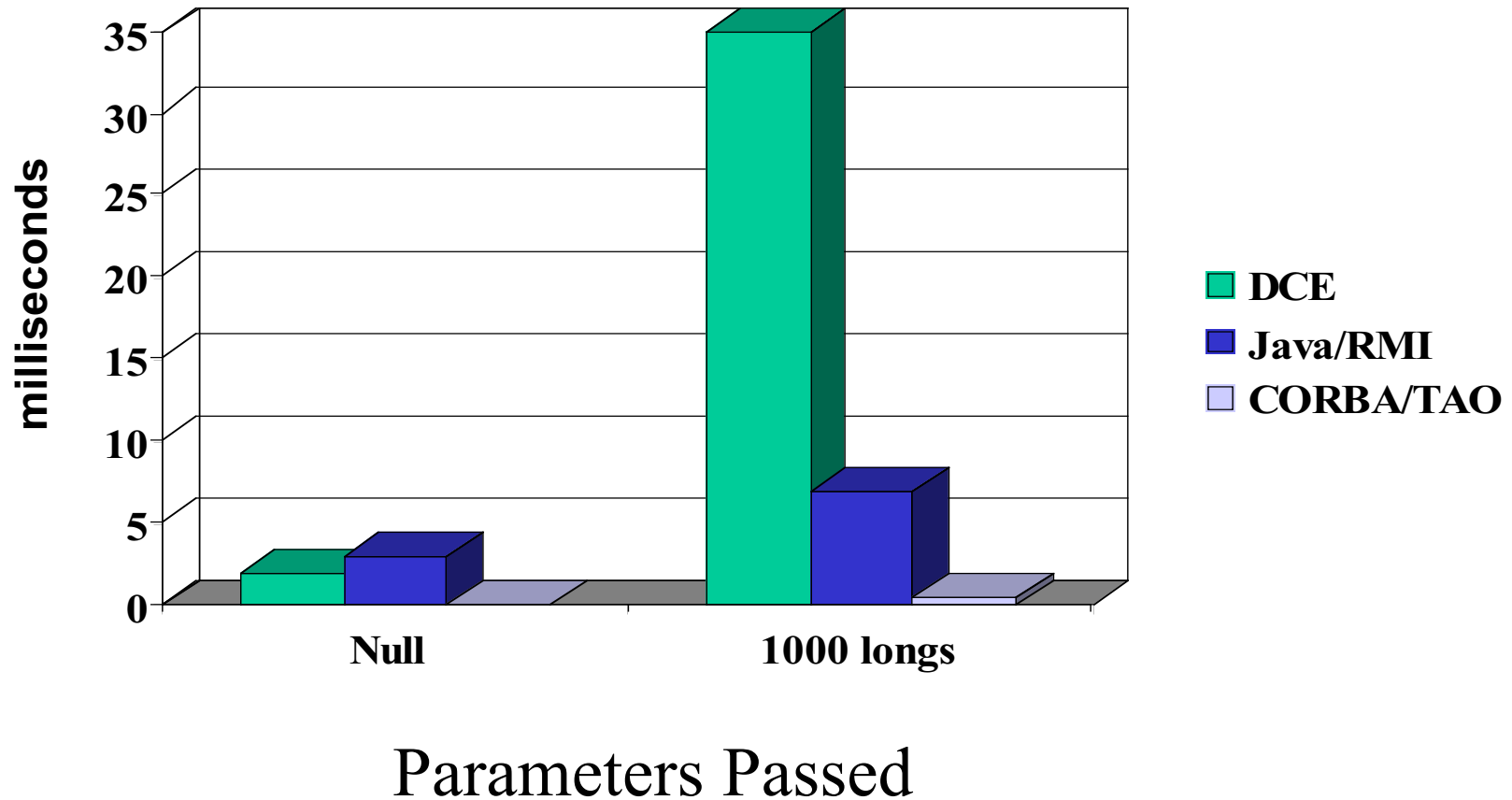
RealTime ORB Performance

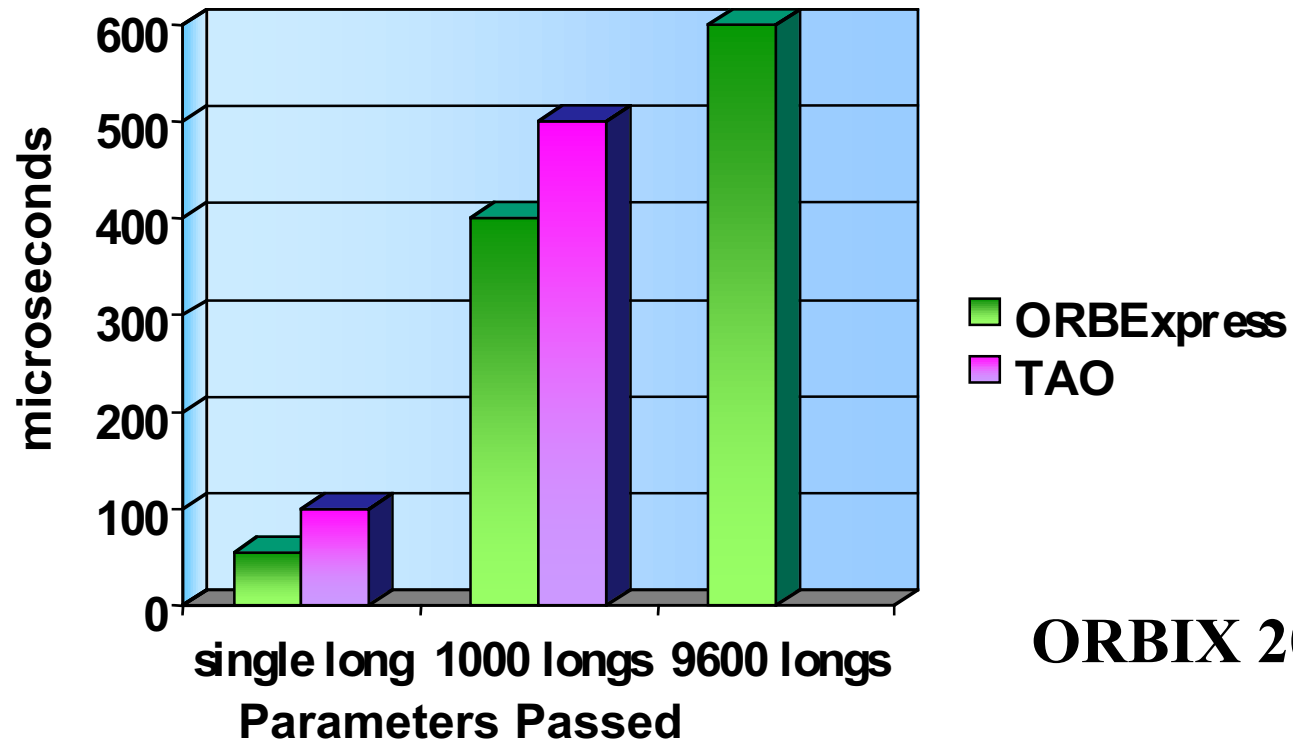**Parameters Passed**

RealTime ORB Performance (microsecond scale)

ORBIX 2000?

Some Military Users of CORBA

Defense Information Infrastructure(DII) Common Operating Environment (COE)

- **DII-COE approved, segmented products for use throughout the Department of Defense (DoD):**
  - **Iona's Orbix**
 - **Borland's Visibroker**
  - **TAO**
  - **ORBExpress**

Military CORBA Projects

- ## Advanced Field Artillery Tactical Data Systems (AFATDS)
  SUN's JavaIDL ORB used for client-server communication.

- ## All Source Analysis System (ASAS) - TAO
  CORBA now in secure version, non-secure code ready.

- ## Joint Tactical Radio System (JTRS)- ORBExpress
  Full CORBA architecture: 200 radios procured, full production later this year.

- ## Joint Tactical Terminal (JTT) - TAO

- ## Updated Early Warning Radar (UEWR) (USAF) - TAO

- ## Maneuver Control System (MCS) - TAO
  CORBA version delivered 4/6/2001.

- ## Integrated System Manager (ISYSCON)
  Architecture planning started.

- ## Army Battle Control System (ABCS 7.0)
  Architecture planning started for next generation system.

Army Battle Command System (ABCS) Architecture

ASAS (TOC Server)

MCS (TOC SVR 2)

MCS

MCS

Router

LAN
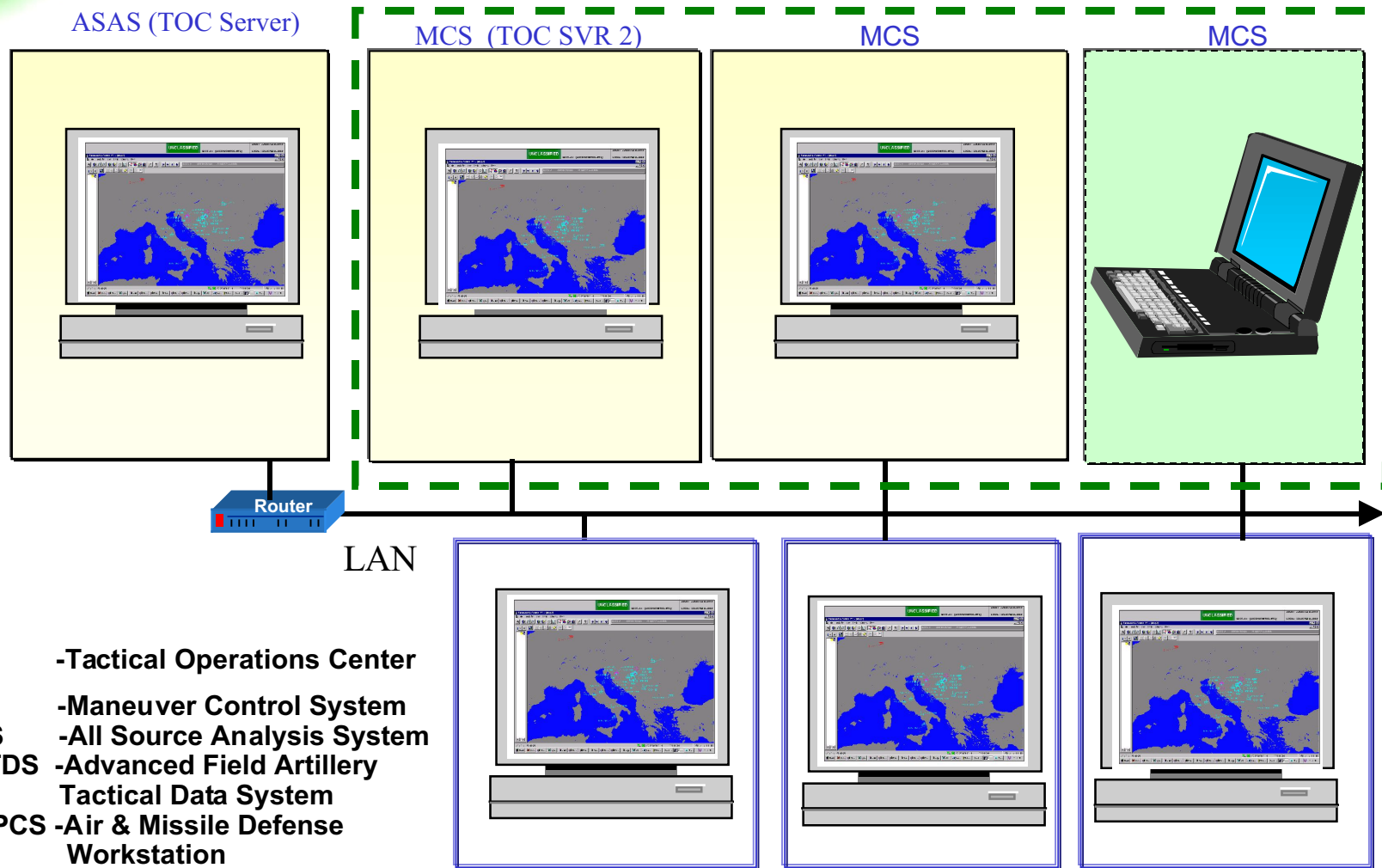
TOC -Tactical Operations Center

MCS -Maneuver Control System

ASAS -All Source Analysis System

AFATDS -Advanced Field Artillery Tactical Data System

AMDPCS -Air & Missile Defense Workstation

CSCCS -Combat Service Support Control System

AFATDS

AMDPCS

CSCCS

6/21/01

17

Steps for Legacy Systems to Full Use of CORBA

1) Replace DCE IDL with CORBA IDL, and use CORBA Name Service for intra-module communications (for some or all modules).

2) Use CORBA for inter-module communications.

3) Use other CORBA Services where appropriate (Events, Notification, Security, Lifecycle, etc.)

4) Use CORBA to communicate with other MCS boxes.

5) Use CORBA to communicate with MCS Notebook.

6) Use CORBA to communicate with other Systems.

7) Drop all use of DCE.

8) Use a distributed object architecture in ABCS (Services: CTP, CMP, Comm Server, Map, Overlay, Collaboration, etc.).

Manuever Control System (MCS): Use of the TAO ORB

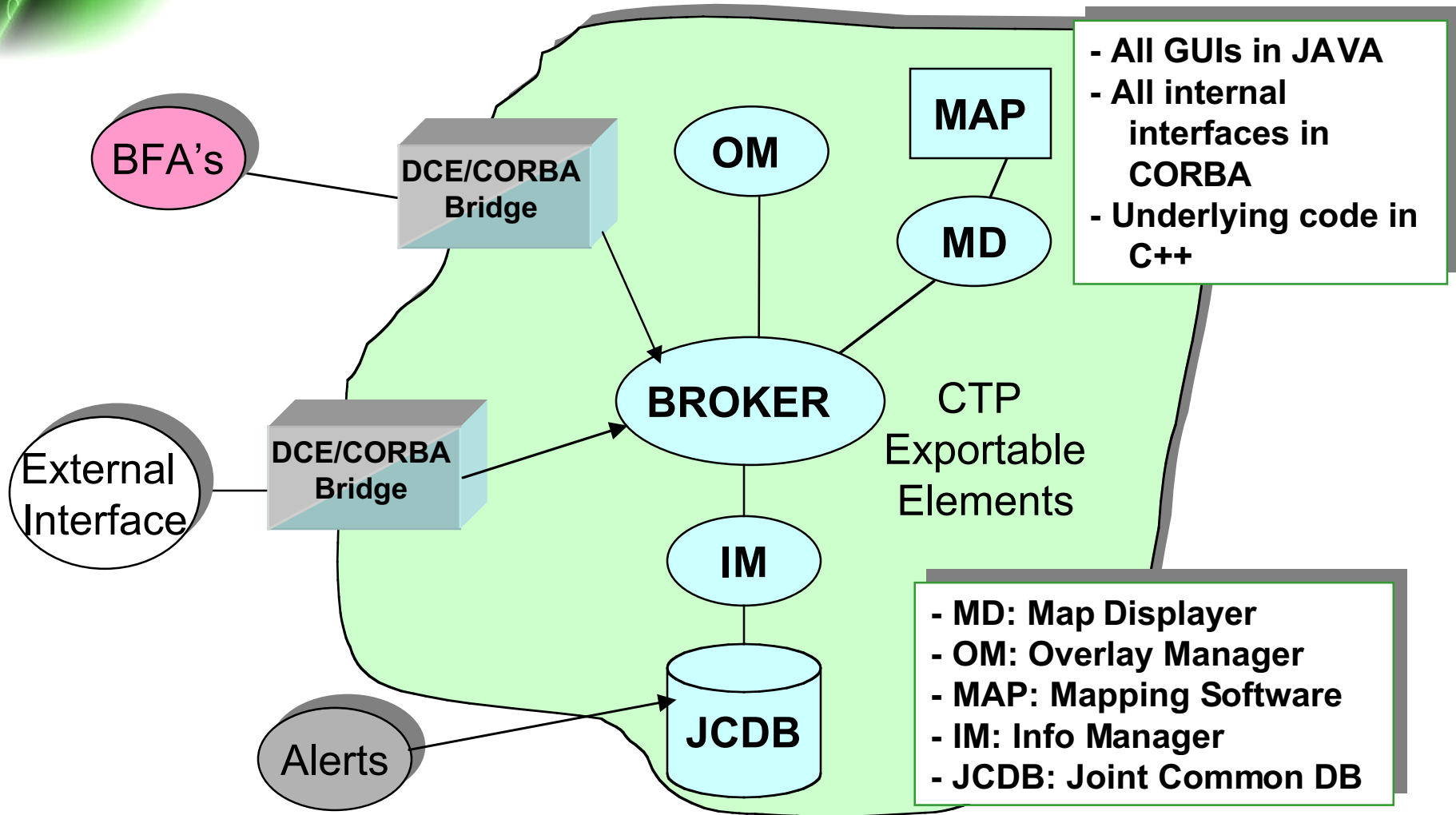**Selected the ACE ORB (TAO) from Washington U., St. Louis: Supported by Object Computing Inc.**

- **TAO is CORBA 3.0 compliant**
- **TAO supports:**
  - Objects by Value (valuetypes)
  - Naming, Event, Notification, A/V and Implementation Repository Services.
- **All Win32 and *nix OSes, BeOS, Lynx, + more**
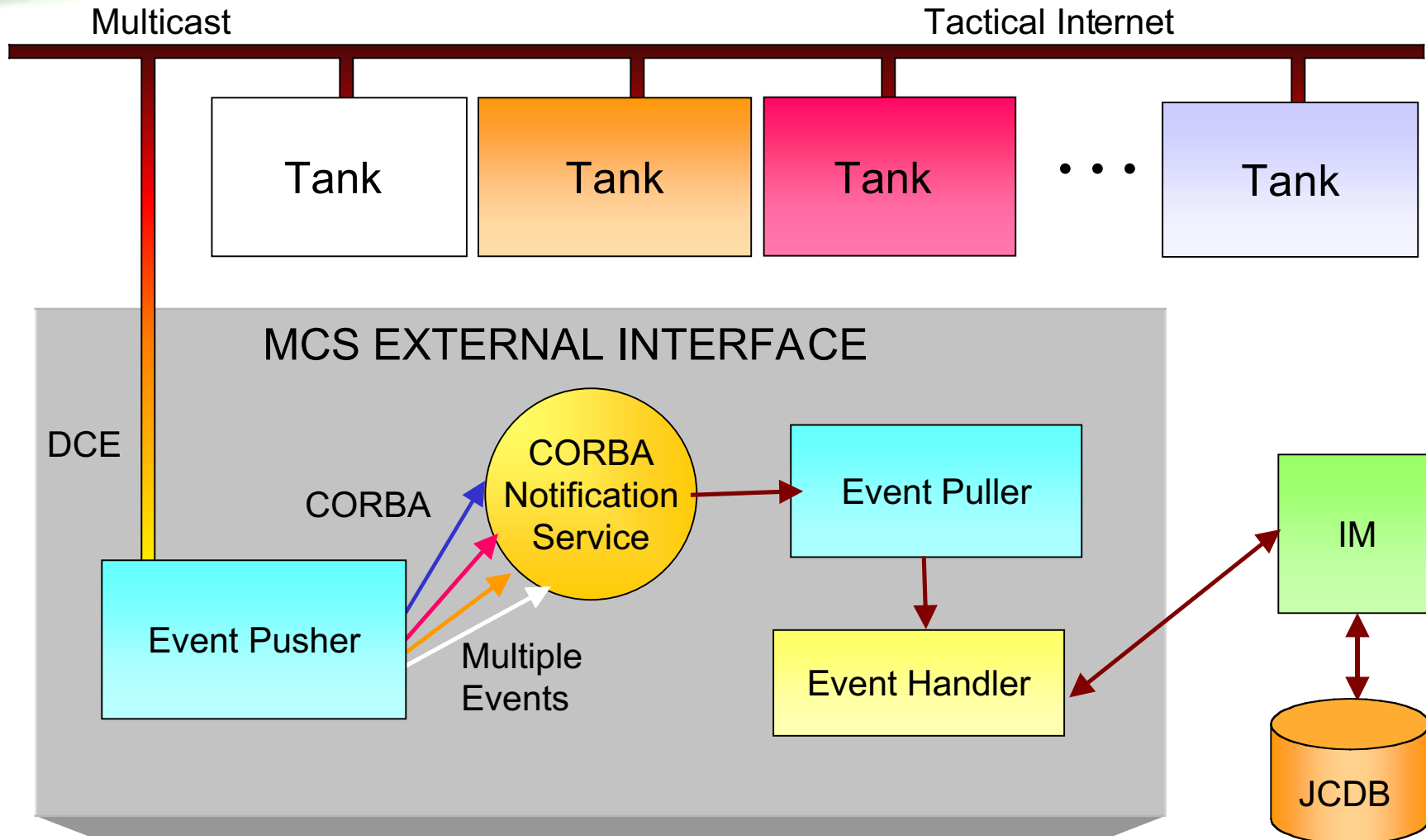- **TAO is Open Source (i.e., free!)**

MCS IDL

- **Servers and clients are already written in C++, but new clients will be written in Java:**
  - **Want to support TAO's C++ IDL as well as Sun's Java IDL.**

- **ZEN (TAO's Washington U. Java counterpart) in development, but not available yet.**
  - **Using Sun's Java IDL compiler in the meantime.**

- **CORBA IDL not compatible with RogueWave tools.h++, dbtools.h++: must convert!**

Common Tactical Picture (CTP) Architecture

BFA's

DCE/CORBA Bridge

External Interface

DCE/CORBA Bridge

OM

MAP

MD

BROKER

IM

JCDB

Alerts

CTP Exportable Elements

- All GUIs in JAVA
- All internal interfaces in CORBA
- Underlying code in C++

- MD: Map Displayer
- OM: Overlay Manager
- MAP: Mapping Software
- IM: Info Manager
- JCDB: Joint Common DB

CORBA in
MCS External Interface
To Provide Live Positional GPS Data

Multicast

Tactical Internet

Tank

Tank

Tank

· · ·

Tank

MCS EXTERNAL INTERFACE

DCE

CORBA

CORBA Notification Service

Event Puller

IM

Event Pusher

Multiple Events

Event Handler

JCDB

Future MCS Directions

- **CONOPS (Continuity of Operations): use Lifecycle Services**

- **Map Server -> Integrated Map Services**

- **Multimedia: Streaming Audio/Video Services provide a growth path for collaboration: VoIP, video broadcasts, etc.**

- **System Manager (SM): use Lifecycle Services**

- **Security: Public Key Infrastructure (PKI)**

Performance Measurements of New MCS CORBA Design

Non-CORBA Design:
~80 sec. to extract & display 772 units

#of units	time,sec
47	5
140	13
219	19
275	25
275	25
313	34
345	34
345	28
511	48
512	53
512	45
512	45
512	47
512	45
772	83
772	78

MCS 6.2.0.7 p8u   December 18, 2000

Time, sec vs Total Number of Units
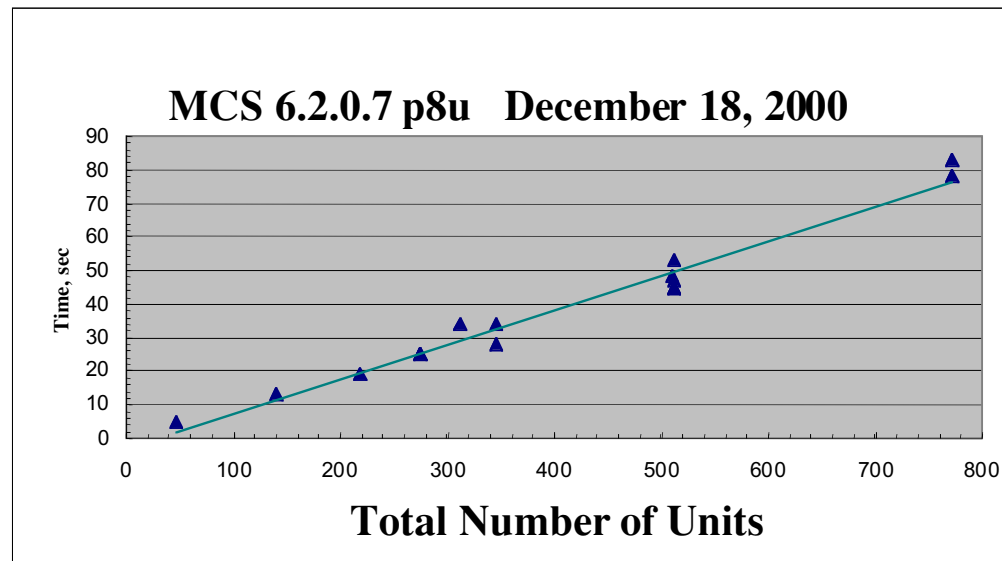
New CORBA Design:

6 sec. to extract & display 772 units

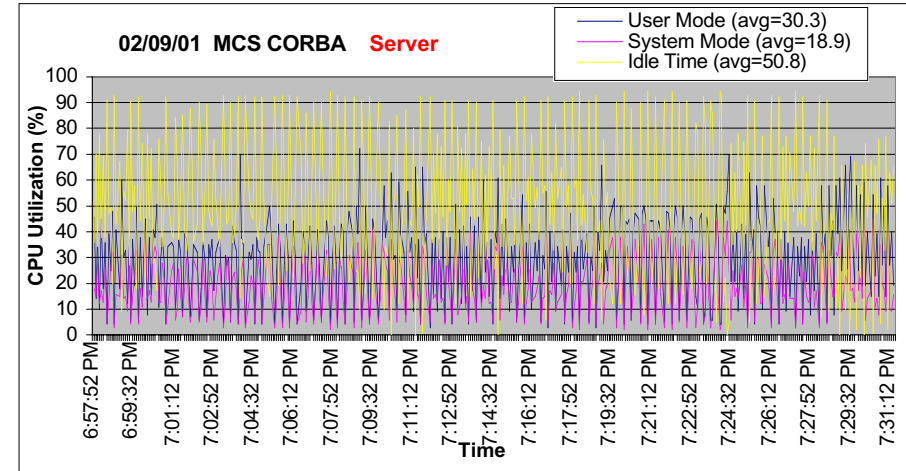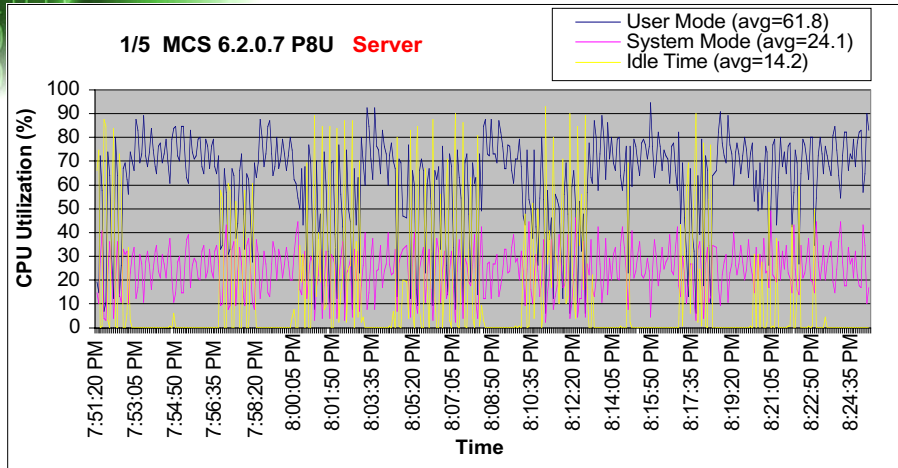| #of units	time,sec
77	1
77	1
102	1
102	1
134	2
134	2
140	1
169	1
179	2
192	1
210	2
275	2
313	3
343	3
348	3
511	4
512	4
772	6
3114	62

Single Filter Extraction, CTP Redesigned Brick, 1/9/2001

Time, sec (Y-axis: 0, 10, 20, 30, 40, 50, 60)

Total Number of Units in One Filter Applied (X-axis: 0, 250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 2750, 3000, 3250, 3500)
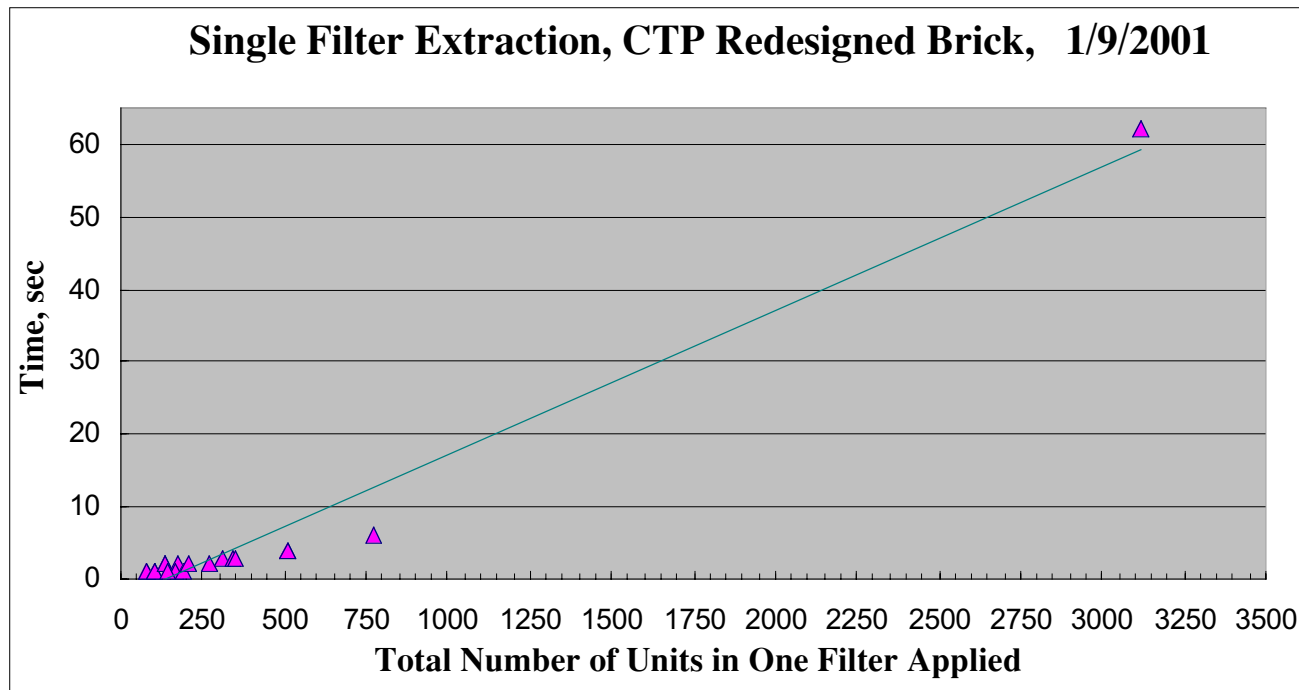
System Time and Run Queue Comparisons

Non-CORBA

CORBA
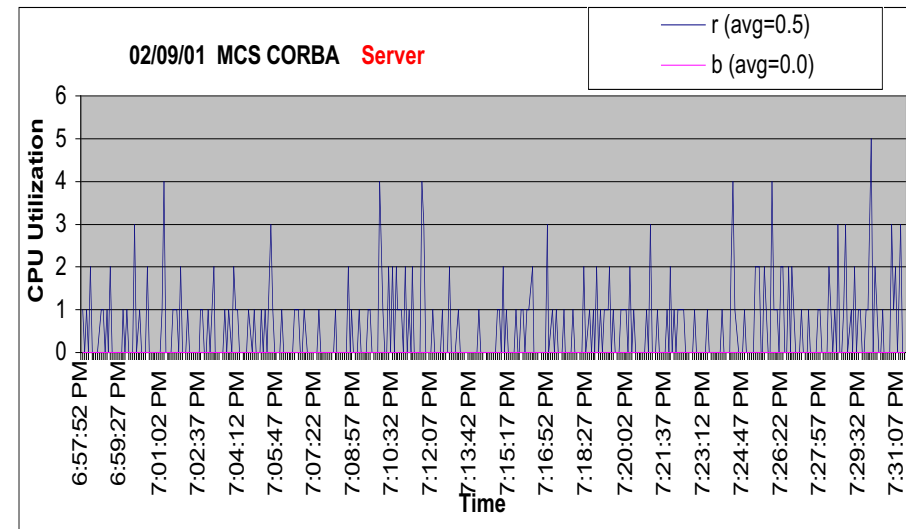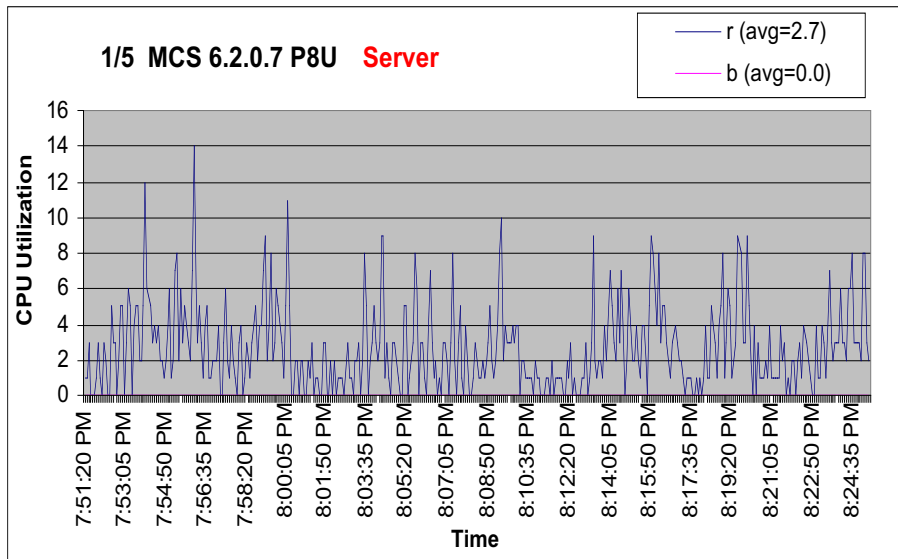
CPU Utilization Comparison

Non-CORBA
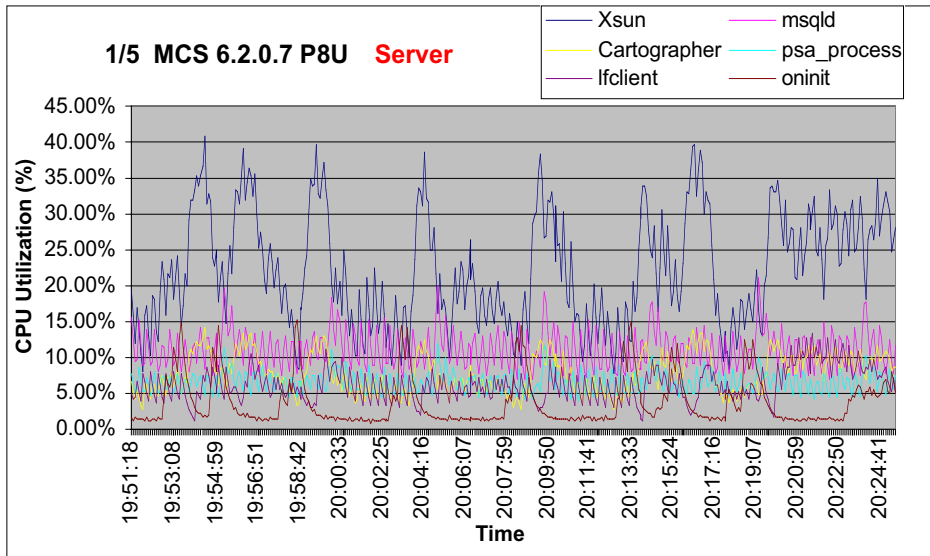
CORBA
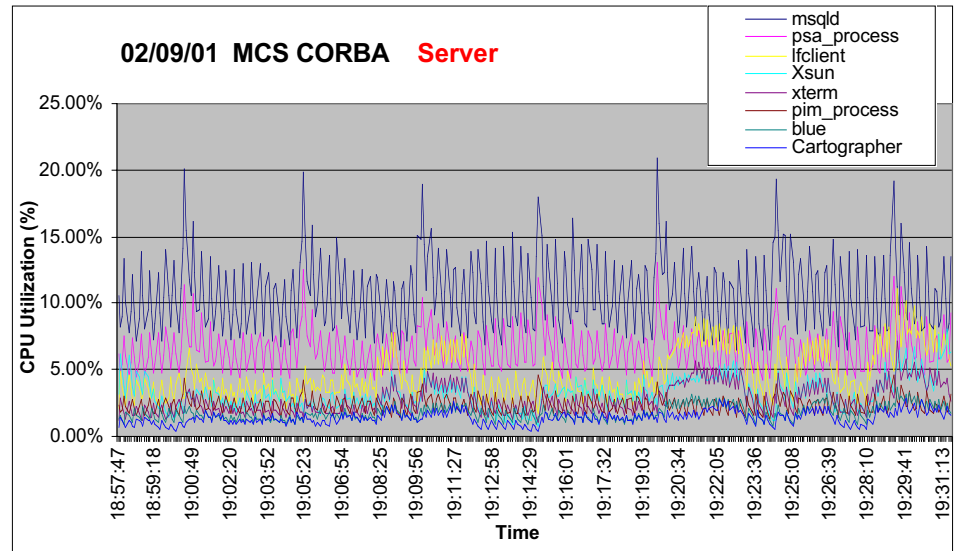
PDA Prototype Architecture for Command & Control Systems

PDA: Personal Digital Assistant (Palm, Subnotebook,Tablet, etc.).
Built for Communications and Electronics Command's
Army System Engineering Organization (ASEO)
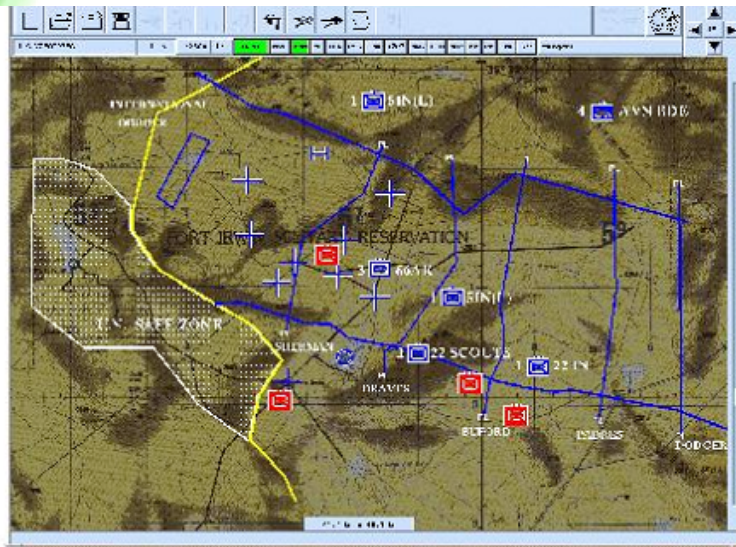
Display

Brigade Commander

Brigade TOC
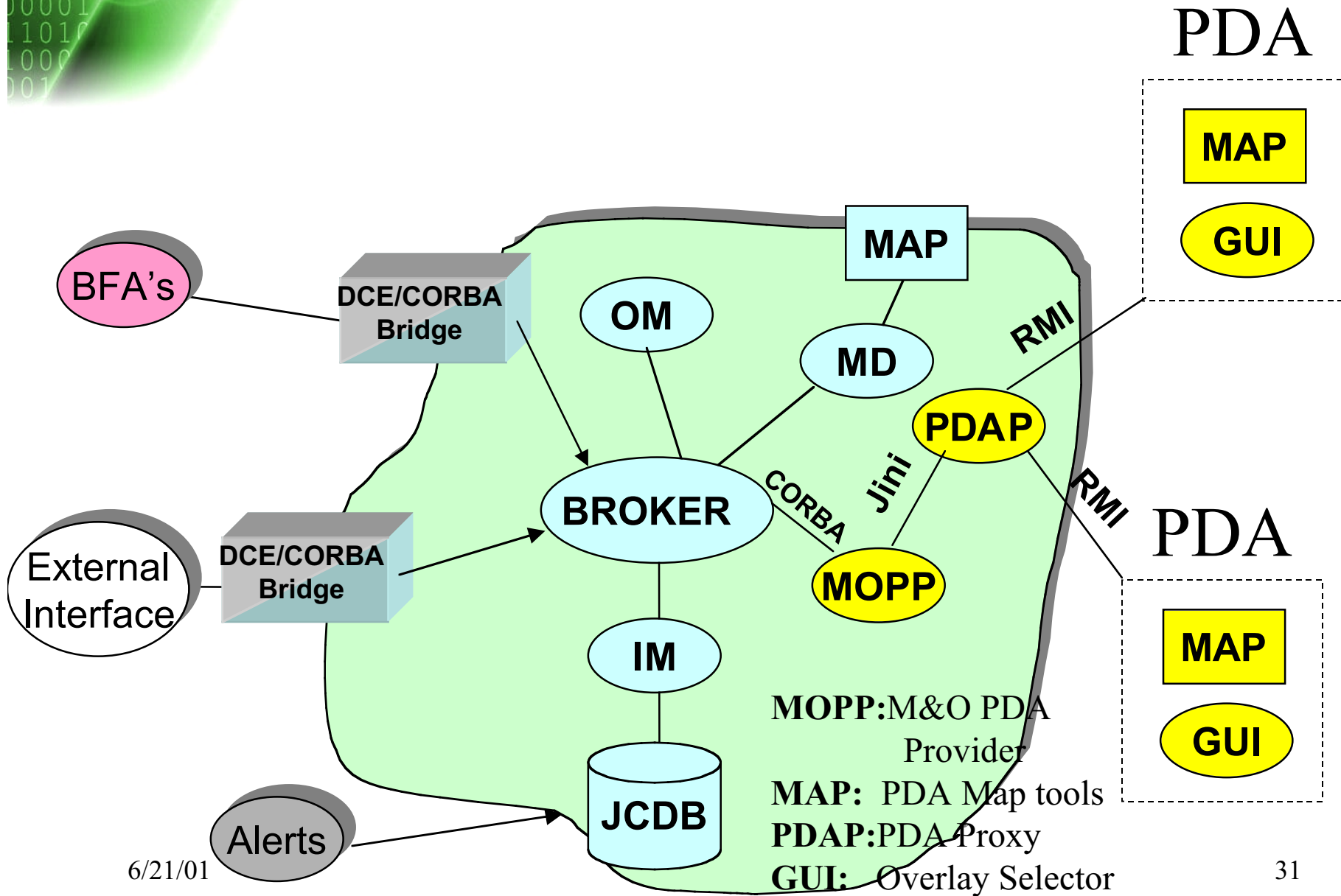
Wireless Link

Wireless Link

CTP Architecture w/ PDA

PDA

MAP
GUI

MAP

OM

BFA's

DCE/CORBA Bridge

MD

RMI

PDAP

BROKER

CORBA   Jini

MOPP

External Interface

DCE/CORBA Bridge

IM

RMI

PDA

MAP

GUI

MOPP: M&O PDA Provider
MAP: PDA Map tools
PDAP: PDA Proxy
GUI: Overlay Selector

JCDB

Alerts

6/21/01

31

PDA Prototype Design.
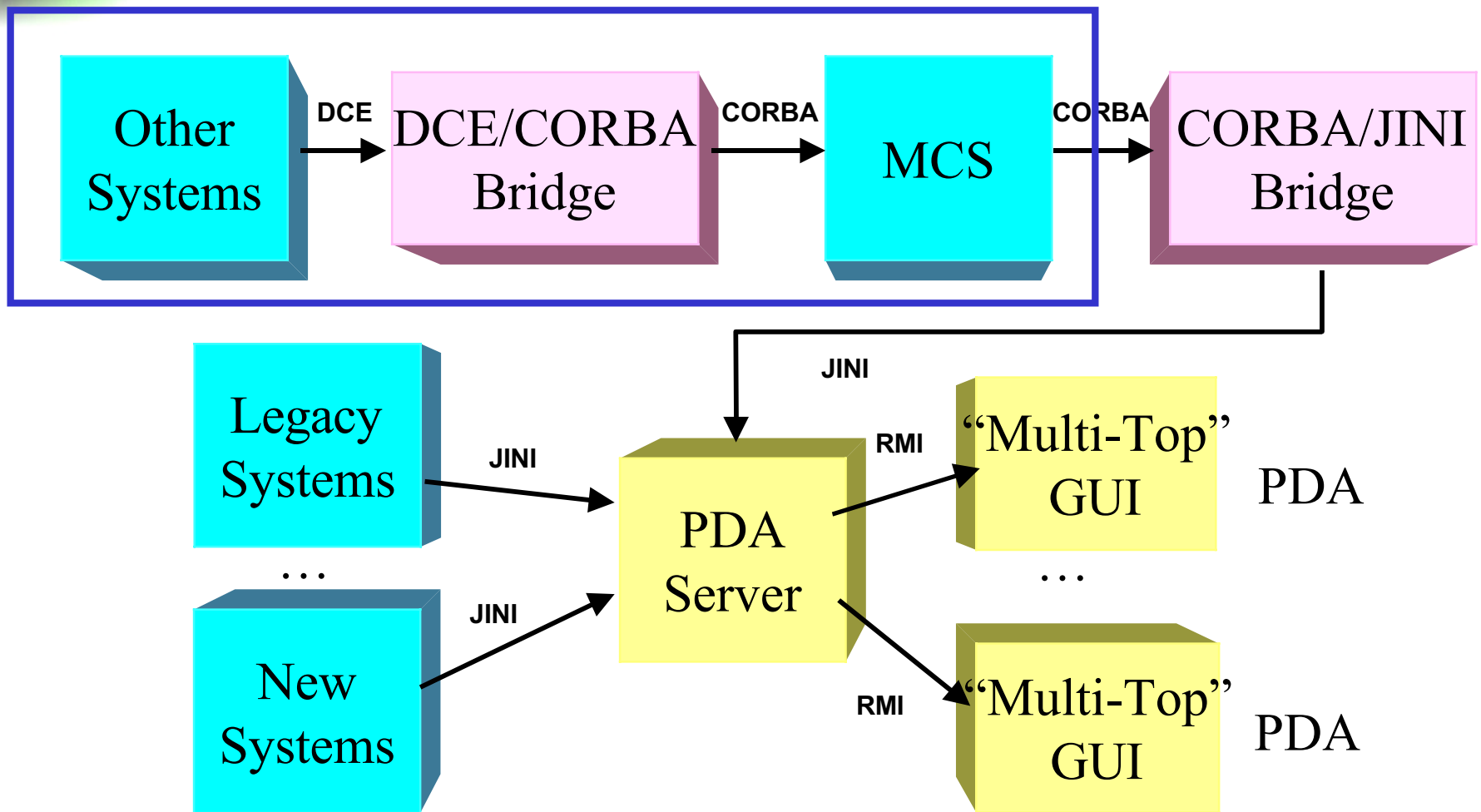
PDA Project Communications View.

JINI

JINI Lookup Service

JINI Client

JINI Services

RMI

New Services
and Components
(JINI, CORBA, EJB)

CORBA

PDA

Legacy Systems
And Services
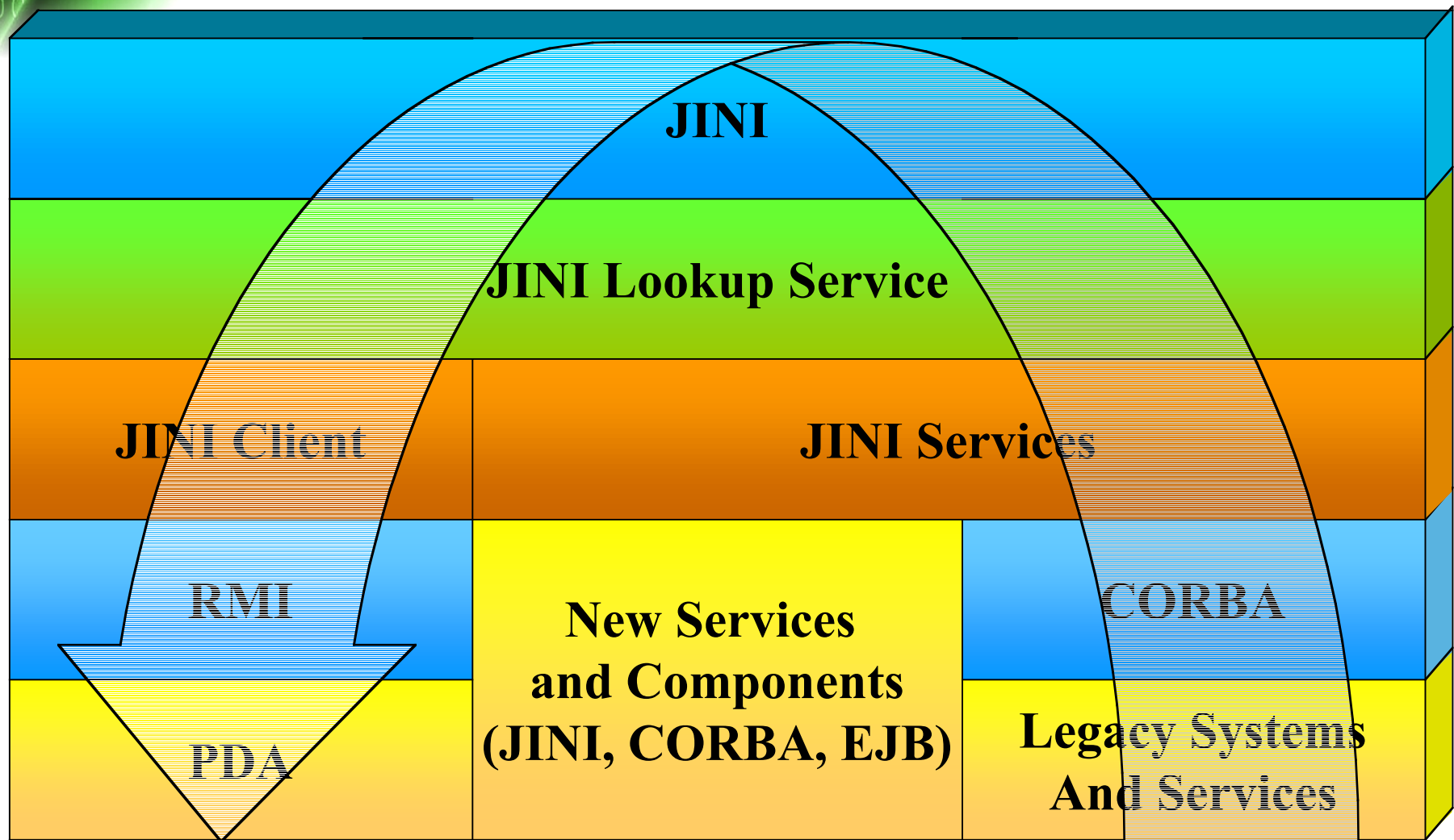
Conclusion: Lessons Learned

• Developers naturally embrace CORBA: it looks great on their resumes, and it is fun to learn.

• Spend time on selling System Engineers, Project Managers, Sponsors and Security Engineers; they will have a natural reluctance to change if they don't know the long-term benefits.

• Take the simple first step in transitioning to CORBA to minimize risk: the bigger steps will follow naturally.

• Have a plan for how to handle non-IDL data types.

• Consider the Security issues up front.

• Be prepared for all sorts of non-related problems to be blamed on CORBA.

Summary

- There are many CORBA projects in the US Army, and more will follow.

- Real Time CORBA has been a catalyst for the adoption of CORBA even when true RT is not needed.

- The future is in the integration of CORBA with other technologies such as JINI, MS.NET, etc….and it is easy!

If you are not saving money and doing impossible things, you've missed the point!

References

- "OO and CORBA on Large Telecommunications Projects," E. V. Shrum, OOPSLA, 1997.
- "Business Drivers to OO and CORBA," E. V. Shrum, AT&T Software Symposium, 1998.
- "CORBA Performance Update," internal memo, John McKim, Mitre Corp. 1/27/1999.
- "MCS Performance Measurements: CORBA vs. Non-CORBA Builds," T. Schmidt, Mitre Corp., 2/27/2001.
- *"DII COE RT CORBA Study,"* presented by vendors at DII COE CORBA RT TWG, 8/2000.
- "Design Patterns for Wireless Thin Client Architectures," P. Wilkes, H. Abeleson and E. Shrum, 2001 Software Technology Conference, Salt Lake City, UT.