TWG-99-02

Directory Challenge '97
Technical Report

FINAL

EMA Directories Committee
Directory Challenge Work Group

May 1997

Electronic Messaging Association
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Acknowledgements

The WEMA Directory Challenge is a cooperative effort, bringing together interested parties (users, vendors, information providers, and system architects) from around the world to address significant directory issues. The huge level of participation in the Philadelphia demonstration of the Directory Challenge is evidence of the high level of interest and need for an interoperable global directory. An effort of this size could only be successful with the support of individuals from each of the participating organizations. Equally important, however, is the dedicated support of the Challenge management team. The Challenge team would like to extend its gratitude to this dedicated group of individuals and their sponsoring companies:

EMA'97 and WEMA Coordinator	Joanne Ghahremani, BT North America
Infrastructure Coordinator	Roger Mizumori, Waterforest Consulting Services
Test Plan Coordinator	Paul Van Avery, FTT Consultants, Inc.
Marketing Coordinator	Ed Harrington, ICL, Inc.
Demonstration Coordinator	Steve Mark, US West
Color Pages Application Coordinator	Marion Royal, US General Services Administration
EDI Application Coordinator	Mary Fisher, Communications by PROXY
VPIM Application Coordinator	Anne Brown, Nortel Technology
Security Application Coordinator	Steve Russell, Worldtalk
Schema Coordinator	Susan May, Concert
Infrastructure Test Coordinator	Lisa Pratt, Boeing
Infrastructure Test Validator	Ted Myer, Rapport Communications
Color Pages Test Coordinator	John Coe, Booz·Allen & Hamilton
EDI Test Coordinator	Bob Carper, Communications by PROXY
VPIM Test Coordinator	Graeme MacArthur, Data Connection Ltd.
Technical Advisor	Alexis Bor, Directory Works, Inc.
EMA Coordinators	Paul Moniz and Tracy Campos
WEMA Regional Coordinators	Colin Robbins, NEXOR (for EEMA)
	Terry Brain, BHP Information Technology (for ECA)
	Rod Cole, Telstra Corp. Ltd. (for ECA)
Technical Report Coordinator	John Coe, Booz·Allen & Hamilton

The Challenge team would also like to recognize a number of individuals whose special contributions to the Challenge helped make the Challenge testing a success: Bill Aitken (Government of Canada, GTIS), John Dale (Soft-Switch), Ian Goldsmith (NEXOR), Frode Hernes (MaXware), Mojtaba Mehrzad (Booz·Allen), Patricia Thurman (Booz·Allen).

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1. Introduction

The Directory Challenge '97 is an unprecedented demonstration of the interconnection of electronic directories of a broad spectrum of user organizations, vendors, and government agencies located worldwide. This capability was demonstrated first at EMA'97 in Philadelphia, PA. The EMA'97 show was a successful demonstration of a global X.500 directory implementation. This initiative went beyond previous pilots and demonstrations to show a feature-rich, practical X.500 directory infrastructure implementation that supports global communications and specific networked applications. The Challenge demonstration provided a highly visible venue for X.500 technologies. In addition, the Challenge demonstrated the need for and feasibility of a public directory service.

The Directory Challenge will continue to evolve for other demonstrations during 1997, first at the European Electronic Messaging Association (EEMA) Annual Conference in Maastricht, Netherlands (June 1997) and then at the Australian Electronic Commerce Association (ECA) exhibition in Melbourne, Australia (October 1997). The Challenge is also being supported by the Japanese Electronic Messaging Association (JEMA) and the Asia Oceanic Electronic Messaging Association (AOEMA). This collection of events and global participation comprises the **"World EMA" (WEMA) Directory Challenge.** This Technical Report summarizes the results of the EMA'97 phase of the WEMA Directory Challenge. Additional reports will be produced following the EEMA and ECA demonstrations.

After October 1997, plans are to work towards continuing the service and transitioning the system into an operational public capability. The EMA Directories Committee and the North American Directories Forum (NADF), in cooperation with the newly formed World Directories Forum (WDF), will most likely provide the leadership for the continued operation in association with the other world EMAs. There have also been discussions about using the Challenge '97 infrastructure for an electronic commerce demonstration planned for next year's EMA'98 Challenge.

As of the publication date of this Technical Report, sixty organizations (with over 30 providing directory data) from the following nine countries are participating in this global directory event:

- Australia
- Canada
- Great Britain
- Ireland
- Japan
- Netherlands
- Norway
- Singapore
- United States

The Directory Challenge '97 is a demonstration of interoperable X.500 electronic directories and directory-enabled applications. This demonstration was conceived to bring together directory vendors, services providers, system architects, and users to accomplish three objectives:

- Facilitate the development of global, public directory services
- Demonstrate directory vendor interoperability
- Demonstrate the use of a directory infrastructure supporting multiple applications.

With these objectives in mind, the Directory Challenge participants, representing the full spectrum of directory interests, created a multi-vendor directory infrastructure based on the 1993 ITU-T X.500 series of recommendations. Access to directory data was provided via multiple methods, including the X.500 Directory Access Protocol (DAP), the Internet Lightweight Directory Access Protocol (LDAP), and World Wide Web gateways.

To advance beyond demonstrations of simple product interoperability, the Challenge participants developed demonstrations of three directory-enabled applications:

- **Electronic Color Pages** — Improves public and employee access to Government services and programs (dubbed "Blue Pages") and personnel ("White Pages").
- **Open EDI** — Uses the Directory Challenge infrastructure as a public repository of organization trading partner profiles. Using a shared directory, companies can establish new trading partner relationships and new electronic data interchange (EDI) credentials.
- **VPIM** — Demonstrates how voice mail systems can store phone number and e-mail address information for Voice Profile for Internet Mail (VPIM) exchanges. Using VPIM, Voice and fax messages can be sent over the Internet (or intranet) from one voice mailbox to other mailboxes without regard to server manufacturer using SMTP/MIME.

The successful demonstration of these applications helps to support the business case for large-scale directory implementations. A fourth directory-enabled application is being coordinated for demonstration at EEMA: secure messaging across the Internet using an X.500 directory infrastructure as the repository of public keys used in the digital signature/encryption process so vital to sensitive electronic commerce (EC) applications.

A formal series of infrastructure tests was executed prior to the Philadelphia demonstration to validate interoperability and ensure that all components were operating as expected. The test results are included in later sections of this report. Rather than assessing "pass" or "fail" of vendors equipment, the focus of the tests was to show stabilized successful interoperability and to detail lessons learned. The applications were also tested based upon formal test suites specific to each application.

The EMA'97 Challenge demonstration showed the feasibility and value of inter-enterprise directory interconnects. A root capability was established and maintained in each participating country to provide the needed linking between organizations. Service providers and vendors were involved with and gained from the lessons learned, while building towards commercial, production level testing and operation. Directory initiatives occurring in customer environments were interconnected and knowledge and expertise was shared to expand upon the global directory system roll-out.

Additionally, the demonstration made significant progress toward its supporting objectives to:

- Overcome perceptions that X.500 is too hard; that X.500 is not good enough; or that it is not ready; and that X.500 will not underlie the Internet directory
- Understand that some commercial perspective is necessary in order for any public directory service infrastructure to happen
- Capitalize on industry lessons learned in large-scale X.500 deployment.

2. Directory Challenge Registered Participants

Organizations participating in the Philadelphia demonstration of the Directory Challenge registered in one of four categories: EMA'97 Show Floor Participant, Demonstration Supporter, Basic Participant, or User-Level Participant. These organizations dedicated personnel, equipment, software, and other resources to make the demonstration work.

EMA'97 Show Floor Participants*	Demo Supporters, Basic and User-Level Participants*
BT Networks & Systems	Access One
Communications by PROXY, an ARINC Co.	AOT Consulting
Control Data Systems, Inc.	Applied Information Management Services
Datacraft Australia Pty. Ltd.	Aspect Computing
Tradegate ECA	AT&T
EDIPORT, Inc.	BHP Information Technology
Enterprise Solutions Ltd.	The Boeing Company
ICL Inc.	Boldon James Ltd.
ISOCOR	Booz·Allen & Hamilton Inc.
Japanese Electronic Messaging Association	BP Oil
Lotus Development Corp.	Brisbane City Council
MaXware	BT Global Communications
MITRE Corp.	CiTR Pty Ltd
NEXOR	Critical Angle Inc.
Siemens Nixdorf Information Systems	Data Connection Ltd.
Soft-Switch Products Division, Lotus Development Corp.	Department of the Treasury
	Digital Equipment Corp.
Telstra Corp. Ltd. Australia	Directory Works, Inc.
Unisys Corp.	Entrust Technologies
VPIM Voice Messaging Committee Work Group	FTT Consultants, Inc.
	Getronics Network Services
Worldtalk	GlobalTel Resources, Inc.
Zoomit Corp.	Government of Canada GTIS
	U.S. General Services Administration
	ICI Australia
	Infonet Software Solutions
	Innosoft International
	Isode Ltd.
	New South Wales State Government
	NTT
	Optus Innovations
	Purchasing Australia
	Rapport Communication
	SITA Group
	St. Paul Software
	State of Texas
	University of Salford
	Victorian State Government
	Waterforest Consulting Services

* Participants as of 4/1/97

3. Directory Topology

The Challenge Infrastructure Team designed an X.500 architecture to demonstrate a global, inter-organizational, public directory and to support the requirements of each of the Challenge applications. The Challenge infrastructure was based on a number of base operating parameters and a coordinated DIT. These items are discussed below. Also shown below is a discussion of the Challenge well known entry points.

3.1 Infrastructure Operating Parameters

The Infrastructure Team established a set of operating parameters to ensure some level of uniformity for the Challenge. These assumptions were intended to mitigate interoperability risks and manage the scope of the Challenge demonstration. Some of the operating parameters were the following:

- **Directory Protocols:** All directory infrastructure components had to be products based on 1993 X.500 and support 1993 DSP. Directory access could be via DAP, LDAP, or Web gateway.
- **Network Protocols:** Infrastructure nodes had to communicate (at a minimum) over the Internet using TCP/IP. Additional connectivity could be performed over OSI or ASYNC connections.
- **Registration:** All top-level US participants were required to register with ANSI, Canadian participants with COSIRA, and other country organizations with their local authority. Unregistered participants could join the directory under c=US, o=EMA.
- **Time Synchronization**: All infrastructure DSAs were required to employ time synchronization with the other components. The Internet Network Time Protocol (NTP) service was recommended and deployed for first-level DSAs.
- **Schema Synchronization**: The U.S. Government schema compiled by the U.S. General Services Administration was adopted for use in the Challenge infrastructure DSAs. This requirement was relaxed during deployment to say that DSAs and DUAs should deploy all parts of the Challenge schema that pertained to their role in the Challenge, e.g., all Open EDI participants deployed the EDI portions of the schema.
- **Paradise/NameFlow Synchronization**: Synchronization with non-1993 X.500 directories (like the Paradise/NameFlow directory) was determined to be beyond the scope and timeframe of the EMA'97 demonstration. The EEMA Challenge team may address this matter.

3.2 Challenge Global DIT

The Challenge DIT is distributed among over 30 DSAs located around the world. The DIT (as of the EMA'97 demonstration) is shown below. As preparations for the EEMA and ECA demonstrations progress, many more organizations will be added to the DIT, particularly under the European and Australian country branches.

In some cases the infrastructure DSAs are live organizational DSAs and in other cases they are demonstration DSAs. During the EMA'97 demonstration, all but two DSAs remained in their "home" location rather than moving to the EMA'97 show floor. Rather than disturb a stable infrastructure, participants used generic and application-specific DUAs to communicate with the DSAs via the Internet. This scenario more closely models a live production environment; it also reveals some of the challenges involved with mitigating wide-area directory performance degradation.

3.3 Challenge Well-Know Entry Points

Nearly all of the 30+ Challenge infrastructure DSAs are configured to support access via both DAP and LDAP. Many also support access via Web browser. Although most participants enter the Challenge directory via their own organizational DSAs, general access is also available at the nine country-level (or first-level) DSAs. In general, all access should be from organizational DSAs, because concentrated connections at the first-level DSAs will seriously degrade network performance. For those organizations that wish to find out more about the policies and procedures for connecting an organizational DSA to a country-level DSA for the Challenge, a list of first-level technical points of contact (POCs) is provided below.

Access to most of the Challenge infrastructure is via anonymous access. Some organizations, however, have chosen to restrict access to some of their directory data to authenticated users. This very closely models a real-world directory with both public and private access.

EMA'97 Challenge First-Level DSA URLs and Technical Points of Contact

Australia (c=AU) and Japan (c=JP)
URL (for c=AU): http://203.55.45.20:9019/v.x500
Mr. Michael Esparon, Telstra
E-mail: mesparon@ventnds3.telstra.com.au

Canada (c=CA)
URL: http://direct.srv.gc.ca/cgi-bin/wgweng
Mr. Bill Aitken, Government Telecommunications and Information Services
E-mail: bill.aitken@gta-atg.x400.gc.ca

Great Britain (c=GB) and Norway (c=NO)
URL: http://193.113.58.35:8888
Mr. Tor Even Dahl, BT (operated by TeleNor)
E-mail: tor.dahl@maxware.no

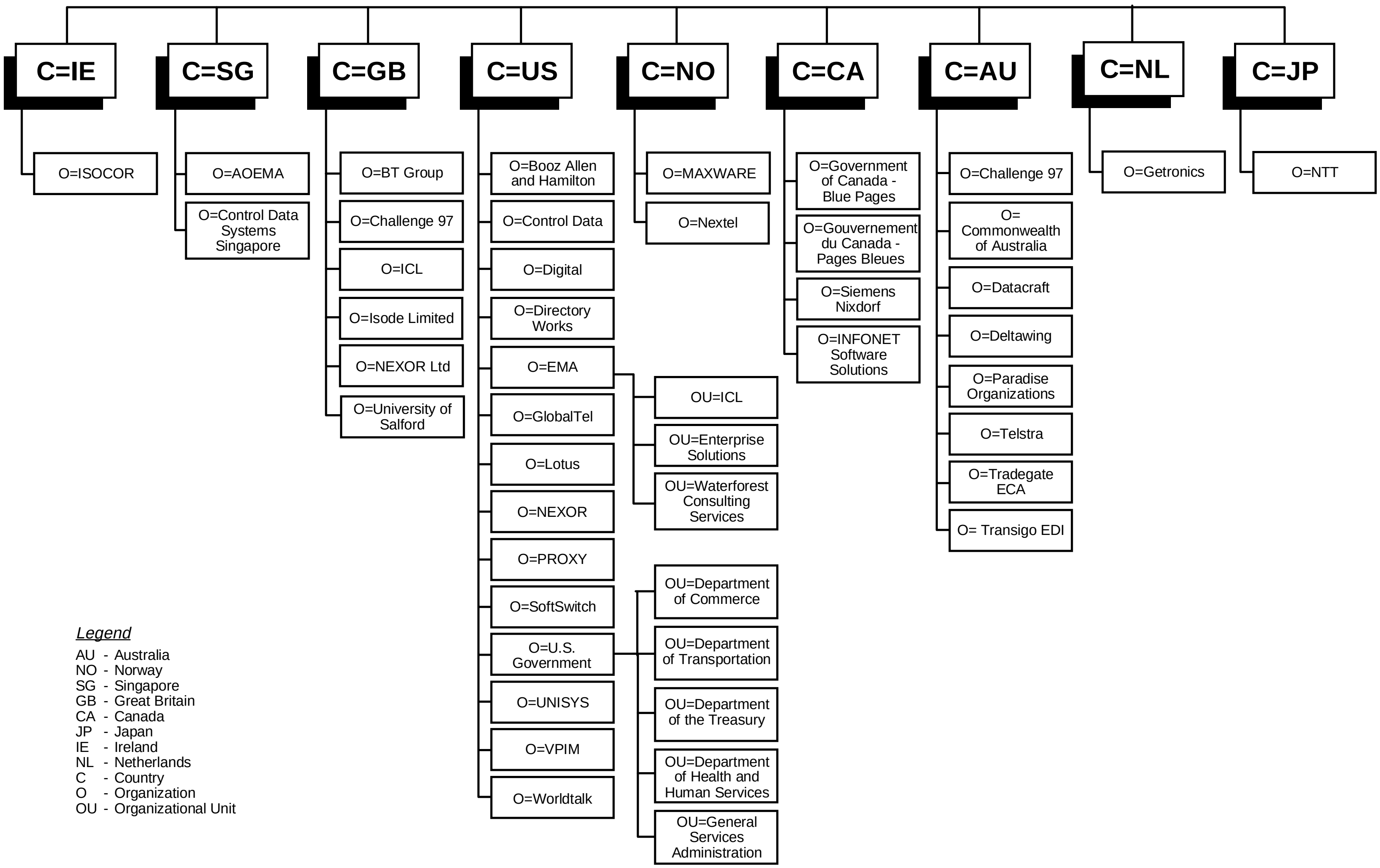
Ireland (c=IE)
URL: http://mulder.isocor.ie:8893
Mr. Jacques Cornily, ISOCOR
E-mail: jacques.cornily@isocor.ie

Netherlands (c=NL)
URL: none
Mr. Theo Bot, Getronics Network Services
E-mail: bot@gns.getronics.nl

Singapore (c=SG)
URL: none
Mr. Ed Greshko, Asia/Oceanic Electronic Messaging Association
E-mail: edward.greshko@cdc.com

United States (c=US)
URL: http://usgold.fed.gov
Mr. Marion Royal, U.S. General Services Administration
E-mail: marion.royal@fed.gov

Directory Challenge '97
Infrastructure DIT



4. Testing Results

The Challenge test team defined a rigorous testing environment to ensure useful, documented, and defensible testing results. Testing roles were defined in the infrastructure and applications teams, and formal test plans were developed for each of these groups. This section briefly describes the testing environment (from the Challenge Test Plan document) and summarizes the test results from infrastructure and applications.

4.1 Testing Environment

The Challenge team established formal testing procedures for the infrastructure and each application. These procedures ensured that all components operated as expected when connected to the infrastructure and that applications could properly use the infrastructure. The Challenge team created a testing team to coordinate all of these activities. The Challenge team tasked test coordinators from this testing team to schedule tests, mitigate problems, and collect results.

Test Parameters

All participants in the WEMA ’97 X.500 Directory Challenge agreed to the following test parameters:

- The test environment was international, and all types of organizations had the opportunity to participate in testing.
- Test Cases were as generic as possible so they could be executed from any region of the world that was part of the Challenge directory infrastructure.
- Testing assumed first level X.500 DSAs supported 1993 X.500 functionality.
- Infrastructure testing utilized the baseline schema designed by the Workgroup, and application testing followed the operating parameters specified by the application groups.
- Testing concentrated on the approved infrastructure and end systems of the Directory Challenge and the use of object classes and attributes necessary to support that environment.

Organizational Test Managers

Each organization participating in testing designated an *Organizational Test Manager*. These individuals were the contact points within organizations for coordination, control, and reporting of test results. These individuals' responsibilities were to:

- Inform Test Suite Coordinators of intent to participate
- Provide the Test Manager contact information
- Assure that testers within the organization participated in prescribed orientation training
- Assure that testers followed procedures and instructions
- Notify appropriate Test Suite Coordinators once all testing by the organization was completed and all results submitted.

Test Suite Coordinators

Each functional subgroup (infrastructure and applications) designated a *Test Suite Coordinator*. These individuals were a source of expertise and assistance to those executing applicable Test Suites. These individuals' responsibilities were to:

- Coordinate system availability and “windows of testing opportunities” between the Test Managers and the backbone infrastructure providers
- Establish the schedule with partners and Test Manager(s) during testing activity
- Attempt to assure that all applicable Test Suites and Test Cases were executed at least once
- Receive completed testing results and relevant documentation from test managers
- Submit all testing results and documentation received to the Test Validator.

Test Validator

An independent *Test Validator*, who was not involved in the testing process, the development of the Challenge infrastructure, or the applications, handled the initial testing review that provided results validation. This individual’s responsibilities were to:

- Receive documented testing results from the Test Suite Coordinators
- Review the testing results submitted
- Validate that the tests appeared to have been properly executed and recorded, and that required accompanying documentation was presented
- Sign off on submitted testing results
- Deliver accumulated testing results and documentation to Challenge Technical Report authors.

Problem Resolution

The testing team made every effort to ensure conformance to the established Test Plan and procedures. The testing team carefully reviewed Test Suites and Test Cases prior to distribution to ensure clarity and accuracy. Test Managers, Test Suite Coordinators, vendors and service providers worked together to maintain a stable and conformant environment. Ideally, if testers encountered difficulties during preparation for testing or during actual test execution, the tester:

- Re-checked the schedule of testing opportunities and the vendors’ “windows” of availability
- Checked with the Test Manager or Test Suite Coordinator to ensure the tester attempted proper tests for the intended application or environment
- Worked with vendors or other participants “at the other end” to troubleshoot and identify potential difficulties
- Briefly but accurately documented the Test Suite and Test Case(s) and the unexpected results or difficulty.

4.2 Infrastructure Testing

Multiple vendors, corporations, and individuals tested the infrastructure in a cooperative and mutually helpful environment. Competitors put aside product and company biases to foster an environment where the success of X.500 was paramount. The goal was not to demonstrate how or where a particular company may have failed, but rather to demonstrate how X.500 succeeded as a technology. The table below lists (in no particular order) the organizations that submitted formal test results. Each organization has been assigned a key which is used in later tables to illustrate who performed particular tests.

Table 4-1: Key To Testing Organizations

Testing Organizations	Assigned Key
Unisys	1
Telstra	2
Soft-switch	3
ICL	4
US GSA	5
FTT	6
Control Data Systems	7
Siemens Nixdorf	8
Isode	9
MaXware	10
ISOCOR	11
Directory Works	12
Worldtalk	13
NEXOR	14

Participants tested the infrastructure with a variety of directory user agents provided by multiple vendors. The list of DUAs reported by the testers is compiled in the table below, along with the vendors that provided them.

Table 4-2: DUAs Used for Testing

DUA	Organization
PC-DUA	NEXOR
DISH	NEXOR
Directory Browser	MaXware
DIRXCP	Siemens Nixdorf
Directory Administration Center	ICL
Tcldish	Isode
Messageware MIDAS	NEXOR
Messageware Desktop	NEXOR
View500 StreamDUA	Telstra
View500 DUA for Windows	Telstra
TransIT 500	Unisys

Infrastructure test results (as of the cut-off date of April 15, 1997) are summarized by DSA in Tables 4-3 and 4-4 below and grouped by country. Three types of infrastructure tests were performed:

- DSP Tests: Successful if a DSA could be accessed via DSP chaining.
- DAP Tests: Successful if a DSA could be accessed by anonymous DAP bind
- LDAP Tests: Successful if a DSA could be accessed by anonymous LDAP bind.

DSP Test Results

In Table 4-4. the letters in each box represent successful DSP tests of a DSA. Unsuccessful tests are not shown. An empty box indicates either that the DSA was never successfully tested, or that no formal tests were performed. Tests results are shown in two columns as follows:

- **Outbound DSP Test**—Each letter corresponds to a remote DSA with which successful DSP communication (through the infrastructure) was made.
- **Inbound DSP Test**—Each letter indicates a successful inbound DSP connection from a remote DSA (via the infrastructure).

Keep in mind that some DSAs were tested much less than others. This is particularly true for the EEMA, ECA, JEMA, and AOEMA participants, some of which came on line in the last days before the EMA'97 demonstration and could not be tested.

While the table illustrates the successful completion of many tests, it also indicates that the testing was not as extensive as originally planned. Ideally, the Challenge team would have finalized the infrastructure much earlier and the testing period would have been much longer than was the case for the EMA'97 demonstration. Now that the X.500 infrastructure is in place, however, future EMA events will not have the difficulty of establishing an infrastructure from scratch.

Table 4-3: DSA DSP Testing Summary Table*

DSA Code	Countries and Organizations	DSA Vendor	Outbound DSP Test	Inbound DSP Test
A	C=United States Also holds: O=Booz Allen and Hamilton	NEXOR	B,D,E,F,G,H,I,J,K,L,N,O,P,Q,S,T,U,V,W,X,Y,a	BIKNWXY
B	O=Control Data	Control Data	ADEFHIJKMNOPRSTUVWXYZa	AIKWXY
C	O=Critical Angle	Critical Angle	-	-
D	O=Digital	Digital	-	ABIKXY
E	O=Directory Works Also holds:	ICL	-	ABIKWXY

DSA Code	Countries and Organizations	DSA Vendor	Outbound DSP Test	Inbound DSP Test
	O=EMA OU=ESL OU=ICL OU=Waterforest Consulting			
F	O=GlobalTel	ICL	-	ABIKWXY
G	O=Lotus	Lotus	-	A
H	O=PROXY	ESL	-	ABIKY
I	O=SoftSwitch	Soft-Switch	ABDEFHJKMN OPQSTUWXY Zab	ABKWX
J	O=U.S. Government** Also holds: OU=Blue Pages OU=Department of Commerce	NEXOR	-	ABIKWXY
K	O=UNISYS	UNISYS	ABDEFHIJMO PQSTWXY	ABIWX
L	O=VPIM	DCL	-	K
M	O=Worldtalk	Worldtalk	-	BIK
N	C=Canada Also holds: O=Govt. of Canada-Blue Pages O=Siemens Nixdorf	Siemens Nixdorf	AEO	ABIKX
O	O=INFONET Software Solutions	INFONET	-	ABIKN
P	C=Australia Also holds: O=Telstra O=Challenge 97 O=Commonwealth of Australia O=Deltawing O=Paradise Organizations O=Tradegate ECA O=Transigo EDI	Telstra	-	ABIKUXY
Q	O=Datacraft	Datacraft	-	AIKY
R	O=AOT	Datacraft	-	B
S	C=Great Britain	Control Data	-	ABIKUWXY
T	O=BT Group	Worldtalk	-	ABIKX
U	O=ICL	ICL	PS	ABI
V	O=University of Salford	Isode	-	AB
W	O=Isode Limited	Isode	ABEFIJKSXZ	ABIKXY
X	O=NEXOR Ltd	NEXOR	ABDEFIJKNPS TWYa	ABIKWY
Y	C=Ireland Also holds: O=ISOCOR	ISOCOR	ABDEFHJPQS WXa	ABIKX

DSA Code	Countries and Organizations	DSA Vendor	Outbound DSP Test	Inbound DSP Test
Z	C=Netherlands Also holds: O=Getronics	ESL	-	BIW
a	C=Norway Also holds: O=MAXWARE O=Nextel	Worldtalk	-	ABIXY
b	C=Singapore Also holds: O=AOEMA O=Control Data Systems Singapore	Control Data	-	I
c	C=Japan	Telstra	-	-
DD	O=NTT	NTT	-	-

Key: C=Country, O=Organization, OU=Organizational Unit
*Test results as of 4/15/97.
**The U.S. Government DSA was moved to a different DSA during testing. This move was transparent to the users and testers.

DAP and LDAP Test Results

In Table 4-4. the numbers in each box represent a successful test of a DSA by the corresponding testing organization (listed in Table 4-1 by number). Unsuccessful tests are not shown. An empty box indicates either that the DSA was never successfully tested, or that no formal tests were performed. Again, keep in mind that some DSAs were tested much less than others, particularly the EEMA, ECA, JEMA, and AOEMA participants, some of which came on line in the last days before the EMA'97 demonstration and could not be tested.

Table 4-4: DSA DAP and LDAP Testing Summary Table*

Countries and Organizations	DSA Vendor	DAP Tests	LDAP Tests
C=United States Also holds: O=Booz Allen and Hamilton	NEXOR	1,2,4,5,6,7,8,10, 14	1,5,10,14
O=Control Data	Control Data	1,5,7,10,14	1,5,10,14
O=Critical Angle	Critical Angle	1,10	1,5
O=Digital	Digital	1,5,7,10,14	1,10,14
O=Directory Works Also holds: O=EMA OU=ESL OU=ICL OU=Waterforest Consulting	ICL	1,5,6,7,8,10,12,14	1,5,10,12,14
O=GlobalTel	ICL	1,2,4,5,7,10,14	1,10,14

Countries and Organizations	DSA Vendor	DAP Tests	LDAP Tests
O=Lotus	Lotus	7,10	10
O=PROXY	ESL	1,2,7,10	1,10
O=SoftSwitch	Soft-Switch	1,7,5,10,14	1,5,10,14
O=U.S. Government** Also holds: OU=Blue Pages OU=Department of Commerce	NEXOR	1,5,7,8,10,14	1,5,10,14
O=UNISYS	UNISYS	1,5,6,7,8,10,14	1,5,10,14
O=VPIM	DCL	5,7,10	10
O=Worldtalk	Worldtalk	1,7,10,13	1,10,13
C=Canada Also holds: O=Govt. of Canada-Blue Pages O=Siemens Nixdorf	Siemens Nixdorf	1,5,6,7,10,14	1,14
O=INFONET Software Solutions	INFONET	1,5,7,10	1
C=Australia Also holds: O=Telstra O=Challenge 97 O=Commonwealth of Australia O=Deltawing O=Paradise Organizations O=Tradegate ECA O=Transigo EDI	Telstra	2,4,5,6,7,8,10,14	14
O=Datacraft	Datacraft	1,2,10	1,10
O=AOT	Datacraft	10	
C=Great Britain	Control Data	1,4,5,7,10,14	1,5,14
O=BT Group	Worldtalk	1,7,10,14	5,10,14
O=ICL	ICL	1,4,5,7,10	1,5,10
O=University of Salford	Isode	2,5,7,10	5
O=Isode Limited	Isode	1,7,8,10,14	1,5,10,14
O=NEXOR Ltd	NEXOR	1,2,4,5,7,8,10,14	1,5,14
C=Ireland Also holds: O=ISOCOR	ISOCOR	1,5,7,8,10,14	5,14
C=Netherlands Also holds: O=Getronics	ESL	7	-
C=Norway Also holds: O=MAXWARE O=Nextel	Worldtalk	5,7,14	14
C=Singapore	Control Data	-	10

Countries and Organizations	DSA Vendor	DAP Tests	LDAP Tests
Also holds: O=AOEMA O=Control Data Systems Singapore			
C=Japan	Telstra	2	-
O=NTT	NTT	10	10

Key: C=Country, O=Organization, OU=Organizational Unit
*Test results as of 4/15/97.
**The U.S. Government DSA was moved to a different DSA during testing. This move was transparent to the users and testers.

Reasons for Testing Failures

Not all tests were successful. Testers encountered difficulties such as:

- Could not contact DSA
- Could not contact host
- Administrative limit exceeded
- Insufficient access rights
- No such object
- Referral returned.

Difficulties in contacting DSAs far outnumbered other problems discovered while testing. These communication problems resulted from:

- Internet problems (see lessons learned)
- Powered off DSA
- Powered off host
- Genuine X.500 protocol communication problems.

Due to the late date of finalizing the infrastructure and the relocation of some DSAs to Philadelphia for the EMA'97 demonstration, many of these errors were undoubtedly due to a powered-down or rebooting computer, or a turned-off or restarting DSA. Remember that the Challenge infrastructure was changing daily up till the time of EMA'97: adding new DSAs, changing knowledge references, upgrading hardware/software, integrating Challenge applications, and general system maintenance in a 24-hour global infrastructure. When all DSAs had the correct knowledge references and all systems were up, actual X.500 protocol communications errors were rare.

A larger issue was the number of administrative limits exceeded. While many errors were probably due to large search results, actual time-outs did occur. This was especially true with DSAs that did not employ time-synchronization with the infrastructure (see Lessons Learned). To increase performance, the vendor community continues to optimize their DSAs, while users look to improve performance by reconfiguring hardware, e.g., disk and memory.

The problems experienced with insufficient access rights either stemmed from administrative experimentation with access controls or actual access violations. Most of these "errors" were actually the results of DSAs doing what they were instructed to do—prevent unauthorized viewing and/or modification of data.

DSAs returning referrals, while not technically an error, caused problems when accessing the directory with DUAs that do not follow or understand referrals (such as LDAP DUAs). Since a failed chain also results in a referral, some referral errors pointed out genuine infrastructure problems, while others were simply configuration issues.

Testing provided the EMA community with valuable insights into implementing a multi-vendor, multi-platform X.500 DIT (see Lessons Learned). As future EMA events continue to help refine the architecture and eliminate errors, the X.500 community will benefit greatly. Increased awareness will enable developers and integrators to produce more compatible, more user-friendly products and solutions, and will contribute to making a heterogeneous, global DIT a reality.

4.3 Color Page Application Testing

The term “Electronic Pages” or “Color Pages” refers to a basic set of directory look-up services conceived to improve inter-governmental communications and Government-to-public communications. The definitions of these services have been designed using the familiar telephone directories as a starting point. The U.S. Federal Government has defined four general Electronic Page services, as follows:

- White Pages—Listing of Government personnel
- Blue Pages—Listing of services provided by Government organizations
- Yellow pages—Listing of services provided to Government organizations (e.g., procurement or contracting services)
- Green Pages—Listing of Government documents and publications.

These definitions were accepted for the purposes of the WEMA Directory Challenge ‘97. (Note that the definition of White Pages was expanded to include non-Government personnel information stored in organizational directories.) As an initial capability, the primary focus was on establishing and testing White and Blue Pages.

The Canadian and U.S. Governments both developed initial demonstrations of both White and Blue Page applications. In addition, a number of companies put corporate White Page information on their organizational DSAs for the Challenge.

Sample Color Page DITs are shown on the following pages. Note that the Blue Pages subdirectory includes an alphabetical listing of valid keywords: the keyword thesaurus. At a minimum, the thesaurus subdirectory will contain a listing of keywords as organizationalUnit entries. Optionally, it may contain further entries beneath the keywords, which contain alias pointers to Blue Page entries that use a particular keyword.

Color Page users can browse or search either with traditional DAP or LDAP directory user agents, or with DUAs or Web gateways that have been tailored to the Color Page applications. Vendors such as MaXware, NEXOR, and Soft-Switch have customized DUAs to demonstrate accessing Color Page data.

Application Testing

The Canadian and U.S. Governments populated their DSAs with Color Page data. Participating agencies in the U.S. Government White Pages are the Departments of Commerce, Health and Human Services, Transportation, and Treasury, and the General Services Administration. Customized DUAs from MaXware, NEXOR, and Soft-Switch tested against this data.

Formal testing was performed using two suites of Color Page tests. To date, all tests have been positive. The data suppliers and DUA vendors worked closely together to make minor adjustments to the schema. The tests were designed to test basic functionality and not implementation-specific features of an organization's particular data.

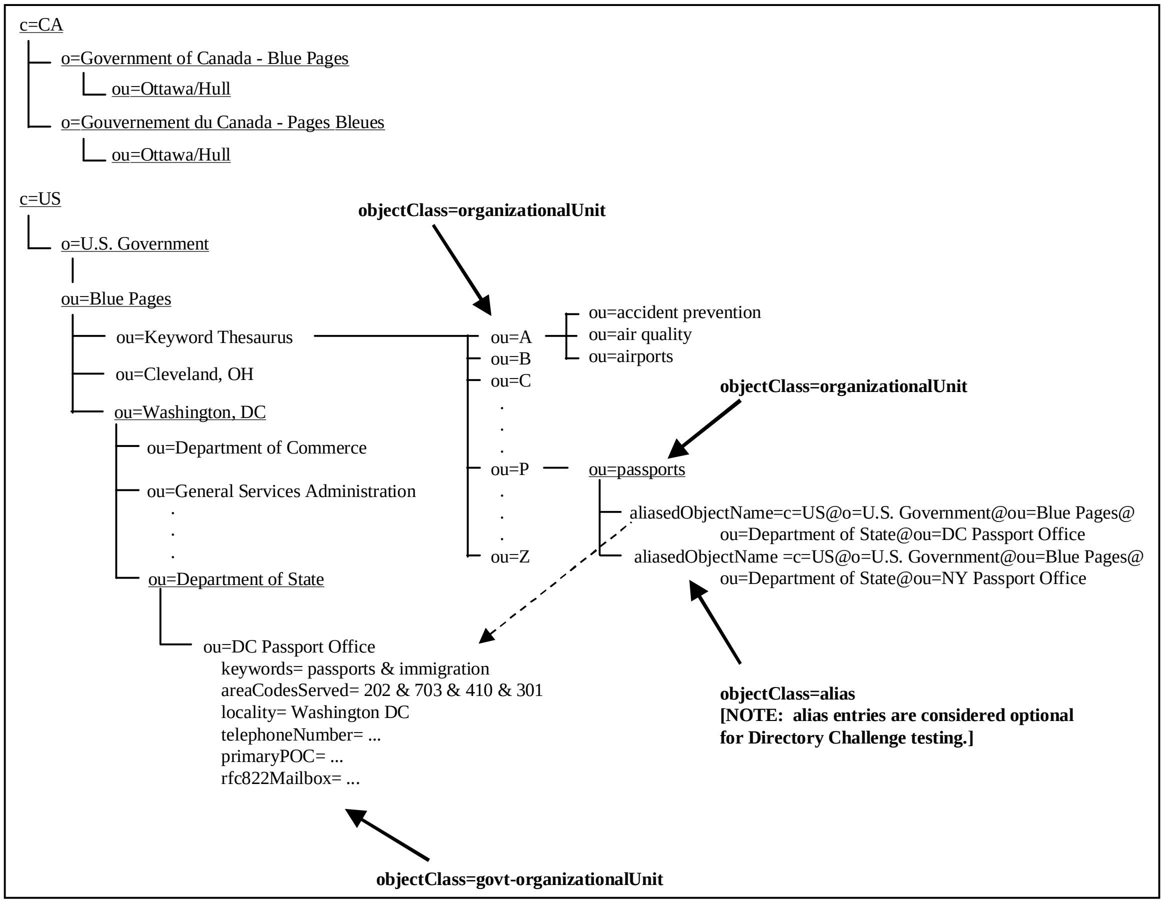
The Color Page tests were the following:

- **Tests To Verify White Page Data or DUAs**
  - Test WP-1: Anonymous Binding
  - Test WP-2: Browsing, Listing, and Reading
  - Test WP-3: Verify Object Classes and Minimum Attributes
  - Test WP-4: Searching Based on Mandatory Attributes
- **Tests To Verify Blue Page Data or DUAs**
  - Test BP-1: Anonymous Binding
  - Test BP-2: Browsing, Listing, and Reading
  - Test BP-3: Searching the Blue Page Thesaurus
  - Test BP-4: Verify Object Classes and Mandatory Attributes
  - Test BP-5: Searching Based on Minimum Attributes

Next Steps

The US and Canadian Governments successfully showed the feasibility of the White and Blue Page plans. Now, the true challenge for these organizations is to develop a feasible data population and management plan to complete these services and provide up-to-date data to their constituents.

Sample of the Blue Pages DIT



Sample of the White Pages DIT

c=US

o=U.S. Government

description= United States On-Line Directory (USGOLD)
businessCategory= United States Federal Government
locality= Washington DC
address= Washington DC
jpegPhoto=

labledURI= http://www.whitehouse.gov Welcome to the White House
labledURI= http://www.uscourts.gov Federal Courts' Home Page
labledURI= http://thomas.loc.gov U.S. Congress on the Internet

- ou=Department of Commerce
- ou=Department of Health and Human Services
  - ou=Administration on Aging
  - ou=Administration on Children and Families
    .
    .
  - ou=Office of the Secretary
    - cn=Stillman, Neil
      surname= Stillman
      title= DEPTY ASST SECTY-INFO RESOURCE MGMT
      locality= Washington DC
      telephoneNumber= ...
      facsimilieNumber= ...
      address= ...
      rfc822Mailbox= ...
- ou=Department of Transportation
- ou=Department of the Treasury
- ou=General Services Administration

4.4 Open EDI Application Testing

The Open EDI Development Group has successfully tested the search capability for both business characteristic data and subsequent EDI identifier data. Using the latest revision to the MaXware Directory Browser and applying some deployment logic in the entry of test data, the team has been able to produce information held by the DIT into a responsive display in the Browser. To date, the Open EDI application has successfully completed the requirements of three of the four tests outlined in the Open EDI Test Plan: Registration (REG-001), Query (QRY-001) and Query2 (QRY-002).

QRY-001 covered the procedure of initiating a query to the X.500 DIT, as covered by the client resident DUA. The tests performed represent that portion of the Business Scenario where Trading Partner B, seeking to do business with a previously-entered Trading Partner A, searches the DIT. QRY-002 covered the procedure of initiating a query to the X.500 DIT as covered by the client resident DUA. This scenario, however, was built totally around EDI as the means of interface to the Open EDI Directory. REG-001 covered establishing connectivity to the DIT and entering basic user information and product/service information through an Administrative DUA (ADUA). REG-002 was deemed not necessary, since REG-001 demonstrated that a DIT entry representing a new registrant could be expeditiously loaded into the X.500 directory through its ADUA. Consequently, all entries in the DIT were entered using an ADUA rather than an EDI-formatted message sent to the DSA.

Work is still required to populate the database with additional test data to provide a variety of companies that can be retrieved based on search criteria entered in the Browser. To register a company in the Open EDI application, the Open EDI team needs the following:

- White Page data: Company name, address, telephone numbers, and contact person(s)

- Yellow Page data: Products manufactured or services provided (SIC Code(s) can be provided)

- EDI Data: Business transactions a company receives or transmits electronically, the EDI standard a company uses and its version, whether company uses a VAN to transmit or receive electronic business data, and the company's DUNS number (if known).

During the show, the Open EDI application elicited participation from EMA'97 attendees to register their company's information.

Recommendations

The present use of directory browsers represents a successful initial step in implementing a search engine that operates below the level of forms-based graphical information. The testing program subsequently utilized a search engine that returned information that was forms-based. This was an initial prototype, however, and not a production system. The testing demonstrated that the Open EDI concept is viable, and that additional work must be spent towards creating a production service. The Open EDI prototype did meet the requirements of initial search capabilities, as expressed in the Business Scenario. A review should be conducted to ascertain if additional information is required to populate mandatory elements of the schema.

Next Steps

The recommendations above and specific refinements detailed in the Test Reports should be implemented. Since sufficient insight was gained in this application to develop a working Open EDI prototype, however, this prototype will be demonstrated at the EEMA '97 and the WEMA '97 events.

4.5 VPIM Application Testing

Voice messaging systems (VMSs) allow subscribers to receive a voice message when they are unavailable to answer an incoming call. These systems are often referred to as "voice-mail" systems. New VMSs will be released in 1997 that support the Voice Profile for Internet Mail (VPIM) which defines a protocol of and extension to Internet electronic mail. VMSs that support VPIM will be able to exchange voice messages over the Internet using Internet electronic mail.

VPIM uses the X.500 directory to retrieve a voice messaging Internet mail address given a phone number. VMSs can also retrieve additional voice messaging attributes, such as spoken name, supported capabilities, and text name.

EMA's Voice Messaging Committee (VMC) defined a service for mapping from telephone number to Internet mail address for use by VMSs. EMA has proposed a way to use the X.500 Directory Services to provide that mapping. Details of the Voice messaging directory sub-tree proposed define LDAP as the protocol for accessing the voice messaging directory. In addition to support for lookup (READ) of an Internet mail address, the X.500-based directory service also supports retrieval of spoken name and text name. The initial voice messaging directory includes a sub-tree structured according to the components of the North American Numbering Plan (NANP). The schema and protocol proposed was focused on the EMA '97 demonstration in Philadelphia, which the VMC used as experience in forming long-term strategy.

In preparation for the Challenge demonstration, the VPIM Challenge group tested in two areas:

- Application Access
- Server Access

A description of these tests and some preliminary results are shown below.

Application Access Testing

For application access, the following test metrics were tracked:

- Applications that could retrieve a VPIM address using LDAP (the primary requirement)
- Applications that could retrieve a Spoken Name attribute using LDAP
- Applications that could administer the directory to some degree (e.g. auto-provisioning of their data in the directory).

For each of these, the following was recorded:

- Whether a company's product/service was able to alpha-test the feature
- Whether a company's product/service was able to demo the feature.

APPLICATION ACCESS METRICS as of 21st March 1997

Company Name	VPIM Address Test	VPIM Address Demo	Spoken/Name Test	Spoken/Name Demo	Administration Test	Administration Demo
Centigram	Y	Y	Y	Y	Y	N
CTIIS	Y	Y	Y	N	Y	Y
Nortel	Y	N	N	N	N	N
ReadyCom	Y	Y	N	N	N	N
IBM/TMA	Y	N	Y	N	Y	N

Server Access Testing

For server access, the following test metrics were tracked:

- Servers that could respond to local LDAP queries only (i.e. those resolved in the local server)
- Servers that could chain requests (using X.500 DSP) to other servers for resolution
- Servers that could shadow information (using X.500 DISP) with other servers.

Again, for each of these, the following was recorded:

- Whether a company's product/service was able to alpha-test the feature
- Whether a company's product/service was able to demo the feature.

SERVER ACCESS METRICS as of 21st March

Company	LDAP Server		X.500 Chaining		X.500 Shadowing	
Name	Test	Demo	Test	Demo	Test	Demo
Centigram	Y	Y	Y	N	Y	Y
CTIIS	Y	Y	Y	N	Y	Y
Octel	Y	N	N	N	N	N
IBM/TMA	Y	N	Y	N	Y	N

5. Conclusions

It would be an impossible task to fix a quantitative measure of success/failure on the Directory Challenge through the EMA'97 demonstration. Counting operational DSAs, calculating percentages of tests passed, and measuring directory performance can only describe narrow aspects of the Challenge's accomplishments. Rather, it is important to consider the qualitative aspects of the Challenge: the cooperative teamwork of vendors from competing companies, the value of the lessons learned, and the contributions towards future standards, products, and public services. These are the measures of success that the Challenge team used to set its goals.

One important goal of the Directory Challenge participants was to work towards defining a business case for inter-organizational and public directory infrastructures and services. The high levels of cooperative participation, press coverage, product availability, and user interest show clearly that directory technologies are of great interest to large and small organizations. The challenge to the directory community is to promote coordinated activities like the Directory Challenge to further advance distributed directory services.

This section presents two assessments of degrees of success of the Directory Challenge. The first is a discussion of how the Challenge met its Critical Success Factors, as established in the Directory Challenge Project Plan. The second is a discussion of ten lessons learned during the course of the Challenge activities.

In all of these cases, it is important to remember that the EMA'97 Challenge demonstration in Philadelphia was the first of three WEMA Directory Challenge events. The solutions developed during the EMA'97 phase will help the other Challenge event coordinators avoid similar problems and take the total WEMA Challenge to a higher level of success.

5.1 Critical Success Factors

The Challenge team defined four critical success factors for itself. This section presents a discussion of the degrees of success against each of the factors.

Successful coordination with directory-enabled Challenge applications.

The Challenge team successfully integrated into the Challenge three organization-sponsored applications that benefit from an X.500 communications infrastructure. (An additional application is planned for the EEMA demonstration.) In this way, the Challenge strove to demonstrate more than simple 1993 X.500 backbone interoperability. Special emphasis was placed on the requirements definition, schema design, and testing to address the utility of X.500 to the applications. It was of the utmost importance to the Challenge team to identify user-organization sponsors for the Challenge applications. This inclusion of user organizations ensured that real-world requirements were brought to the Challenge and incorporated into the infrastructure design.

Coordination among the world messaging associations.

Three regional messaging associations are championing the WEMA Directory Challenge '97. The Challenge's inaugural event was at the North American EMA'97 show in Philadelphia, PA (April), which this Technical Report summarizes. The EMA'97 demonstration will be closely followed by a second event in June—the European EMA (EEMA) Annual Conference in Maastricht, Netherlands. Finally, the Challenge is part of the October meeting of the Australian Electronic Commerce Association (ECA) in Melbourne, Australia. Member organizations from each of the three associations are working cooperatively to support the Challenge through all three events.

Meeting each Challenge application's requirements.

All applications teams included users, application and X.500 vendors, information providers, and system architects. Working with the Challenge infrastructure team, the application teams ensured that all of their applications' requirements were met, where possible, or that acceptable solutions were developed. As of the EMA'97 show, all three Challenge applications had successfully tested to some degree using the directory infrastructure. By design, actual success of the WEMA Challenge will be measured in how well the infrastructure met the applications' individual requirements.

Establishing a Challenge directory infrastructure that "works".

The Challenge infrastructure team designed an infrastructure of over 30 X.500 (1993) DSAs, distributed around the world and communicating over the Internet. DSAs from the major X.500 vendors were included in the infrastructure. The team designed a base schema, starting from a comprehensive schema developed by the U.S. Federal Government. Multiple access mechanisms were integrated into the directory, including well known entry points supporting DAP, LDAP, and HTTP Web access.

Thanks to a rigorous implementation and testing process, the directory infrastructure is approximately 90% operational. Not all components that were added later in the process have been fully integrated into the infrastructure. These and other components will continue to be added through the other WEMA events. Note that successful connection to the infrastructure is not predicated on having full feature interoperability; in other words, a component can connect successfully to the infrastructure and communicate with its direct-connects and peers, but not be fully interoperable with every other component for all features and services.

As expected at the onset of the Challenge, there were problems to overcome on the road to Philadelphia. The vendors worked closely together to identify and resolve interoperability problems and to feed this information back into the standards bodies and to their own product development processes. Some of these problems resulted in valuable lessons for future, large-scale directory implementers.

5.2 Lessons Learned

The WEMA Directory Challenge activities have facilitated an important exchange of ideas between members of the directory community of users and vendors. The Challenge has also proved to be a valuable interoperability testing ground for 1993 X.500 products. The Challenge participants learned a number of valuable lessons about large-scale, multi-vendor directories. Many of these "Lessons Learned" are included in this Technical Report.

The Challenge participants hope that the lessons learned presented in this report will feed into the EEMA and ECA Directory Challenges to mitigate the effect of similar problems and to enable the development of further lessons learned. In addition, directory system implementors should use this report and its lessons prior to and during a large-scale, enterprise-wide directory system deployment. The results and lessons learned provide a reference for consideration during deployment. Finally, the standards community and others involved in preparing detailed X.500 directory technology specifications can use the results documented in this report to further detail and refine protocols, standards, and specifications. This report provides specific examples and instances where optional features and functions identified in the standard need to be selected or further specified to achieve a fully interoperable enterprise level system.

Lesson #1: It is important to synchronize network times in a widely distributed global X.500 directory services environment.

The X.500 protocol is designed such that the clocks of all servers (DSAs) must be in sync to within a very few seconds, but it does not impose any synchronization requirements on the clients (DUAs). Since timing is critical to DSA operations, all administrators for a specific DIT must synchronize their DSAs to the same time. If there is even a small difference in the universal time on the clocks of the systems involved, the consequences are significant. If the originating DSA stamps an operation at 16:00:00 and has set a 15 second time-out, and the receiving DSA thinks the time is 16:00:20, the operation will experience "communications time out value exceeded" upon reaching the target DSA even if the communication path is instantaneous, which is unlikely.

The solution was for all the universal clocks in the distributed computers to have the same time values. To accomplish this, Challenge infrastructure and application participants selected the Network Time Protocol (NTP) to set a single system time for the entire Challenge. This is an Internet standard method of ensuring equal clock values and free NTP software is available on the Internet at:

http://www.eecis.udel.edu/~ntp/ (for UNIX systems)
ftp://ftp.drcoffsite.com (for Windows N/T)

For the latter site, send e-mail to "access@drcoffsite.com" to obtain the ftp password necessary to establish your ftp session.

Lesson #2: There is an important difference between the way X.500 DAP and versions of LDAP process certain directory operations.

A DUA which uses the DAP protocol performs an X.500 LIST operation by retrieving the Distinguished Names of the immediate subordinates from the knowledge references held by the target DSA. In performing this LIST, the DSA should contact all subordinate DSAs to check each entry's access controls. If a subordinate DSA is unavailable, or a response is delayed, then a referral is returned. (Note that some DSAs do not always contact subordinate DSAs during a one-level LIST.) Thus, a DAP LIST inquiry directed at the "C=US" DSA by DAP DUAs should always return the known subordinates.

The LDAP protocol substitutes a SEARCH operation in an attempt to accomplish the same result as a LIST. The LDAP implementations actually search the directory for the subordinate entries themselves in order to construct the response to the inquiry. If a given subordinate DSA is disconnected from the infrastructure or temporarily unavailable, the LDAP DUA does not "find" it and thus does not return its entry, because LDAP does not return referrals.

Users and administrators should be aware of this important difference between DAP and LDAP DUAs. To ensure reliable results in an LDAP environment, administrators might try replicating organization entries to their parent, first level DSAs (see Lesson #7).

Lesson #3: There are important differences in vendor implementations of X.500 replication.

X.500 (1993) introduced a standard model for data replication. A new inter-DSA communication protocol, Directory Information Shadowing Protocol (DISP), was defined to handle this specialized function. There are differences, however, in the manner in which DISP connections are established. These differences lead to incompatibilities between DSAs. For this reason, inter-vendor replication was not required for participation in the Challenge infrastructure, nor was replication tested as part of the infrastructure testing.

There are two general mechanisms for establishing replication connections:

- Directory Operational Binding Management Protocol (DOP)—Some DSAs establish DISP connections using the inter-DSA DOP protocol.
- Shadowing Agreements—Some DSAs use a file-based mechanism to establish DISP connections. DSA administrators on both ends of a DISP connection prepare shadowing agreement files on their DSAs, which formally sets up a supplier-consumer relationship

Replicating subtrees of the DIT is also problematic, since some vendors have implemented subtree cuts, while others expect to replicate their entire portion of the DIT. Vendors continue to address the replication and shadowing issues today.

Lesson #4: DSAs and DUAs do not always handle errors the same way.

Since LDAP does not follow DSA referrals and DAP does, different DUAs can respond with different results from the same search. DUAs can automatically follow a referral, query the user before following a referral, or produce an error. This means that LDAP DUAs may return a reduced picture of the DIT.

DSAs and DUAs also handle actual errors quite differently. While no DUA or DSA should crash or cause a crash, this behavior has manifested during testing. Beta and untested products contributed to some problems, but X.500 interoperability is an area the vendors will continue to work to improve.

Lesson #5: Network problems and delays coupled with system outages can cause disruptions in directory service and variable results.

The Internet is inherently unreliable. Performance is variable and outages do occur. Whether a link is quick or slow can determine if a time limit is exceeded or not for a particular query. The load on a DSA can also cause exceeded time limits. Users and administrators should remember that performance is dependent on multiple factors and will vary. X.500 includes features for mitigating such problems, e.g., shadowing and alternatives in references.

Lesson #6: Synchronizing first-level DSA knowledge references is critical and time consuming.

Users are disconcerted when connecting to one first-level DSA yields a different list of countries then when connecting to a different first-level DSA. The list of countries needs management and consistency across all first-level DSAs. Administrators should not add a county to their DSAs until that country's DSA is connected and running properly. Then all first-level DSAs should add the country on the same day, if possible. An inconsistent DIT undermines user confidence. Maintaining consistency, however, requires coordination and administrative overhead and takes time. Establishing clear lines of communication and authority for country-level DSAs would mitigate the logistical problems inherent in such a distributed system. Work is underway to deploy and infrastructure to keep country-level DSAs in sync within the next year.

Lesson #7: Top-level organization replication could improve performance and make the directory less susceptible to outages.

When a DUA is referred to or has to chain to another DSA, response time slows. This decrease in speed is due to the X.500 DSA/DUA communication over the Internet infrastructure. Minimizing inter-DSA communication and maximizing intra-DSA knowledge is preferred to ensure fast response time. A local copy of the next level of DIT information improves DSA performance. Likewise, reliability improves when user-initiated communication between DSAs is minimized. A user would never be aware a system is down if the DSA he or she connected to had a copy of the problematic DSA's data. The difficulty is doing replication in a heterogeneous environment (see Lesson #3).

At the world and country levels, replication of the country information and the organizations subordinate to each respective country could improve performance problems due to the DAP list/LDAP search issue (see Lesson #2). For example, to search under a country entry, the country DSA must chain to each of the subordinate organization DSAs. If any of these DSAs does not respond or if a response is delayed, then the country DSA will not return the non-responsive DSA's entry. A proposed solution is to replicate the organizational entries to the country level DSAs. This would enable a country DSA to perform a one level list or search without contacting other DSAs. This solution has been proposed for testing during the EEMA phase of the Directory Challenge. Work is underway toward this end.

In addition, another type of replication is also highly recommended to ensure smooth and continuous directory operations—replication of data from critical components. Data replication, uninterruptable power supplies, swappable systems, and regular backups all contribute to making the directory less susceptible to outages.

Lesson #8: Standardizing administrative limits across DSAs could provide consistency and improve performance.

Users are confused when one DSA returns 200 entries for a search before returning an "administrative limit exceeded" error while other DSAs might return 50 entries before returning the same error. In an effort to improve performance, some DSAs have configured administrative controls over the number of entries to return. Standardizing these limits could provide a more consistent interface to the users. Setting an appropriate value could also help improve performance. On the other hand, DSA administrators need to reserve the right to adjust administrative limits depending on conditions and to the degree permitted by service level agreements. This is an important issue for DUA vendors to address within their user communities.

Lesson #9: Default DSA access controls are often insufficient for operational systems.

Many DSAs ship with minimal access controls enabled. When installing a DSA "out-of-the-box," administrators should immediately disable anonymous modification of the directory and anonymous reading of passwords. These steps will mitigate the risk of unexpected changes in the directory. *Waiting* to implement a security policy often results in *never* implementing a security policy.

Lesson #10: A single global schema is not required or feasible.

At the beginning of the Challenge activities, a common schema was adopted for deployment across all infrastructure DSAs. As work progressed, however, and applications provided local changes to the schema, it was determined that global management of a common schema was generally not required for effective interoperability. Since only the DSA storing information and the DUA requesting the information need to know the schema for that information, a single global schema is not required. Intermediate DSAs do not need to understand the schema for information passing through them. As long as the DSA storing data in a specialty schema understands that schema and users accessing a specialty schema have a DUA capable of understanding it, no other DSAs in the DIT need to understand it. DUA understanding is optional, as many DUAs will simple display the numerical OID and corresponding value if they do not understand the schema. As long as a standard base exists for the common attributes, organizations will be free to expand their schemas and are not obligated to implement other organizations' schemas.

Appendix A: Directory Time Synchronization

Overview

The X.500 protocols assume the use of universal time, which is also used internally by most computers, with appropriate conversions to the local time zone. Universal time methodologies (such as GMT, Zulu and UTC) do not change with shifting local time zones and daylight savings time changes.

The Challenge participants, however, learned that it is wise to verify proper management of all aspects of time synchronization. Verification of computer clock time management is needed for both time zone and daylight savings time. Do not assume that all the computer clocks throughout a large infrastructure are equally efficient. Synchronization of the seconds level required research and the implementation of a common solution.

Even though X.500 (and most computer clocks) uses Universal time (GMT, UTC), computers often allow the time to be displayed and set in terms of local time. Confusion about how computers handle the setting of time and time zone offsets sometimes results in clocks being set wrong.

Seconds really do count. Even when time is set correctly in X.500 components, the computer clocks distributed throughout a global environment still will not be precisely synchronized without an additional step. Even if they were perfectly synchronized on some arbitrary "start date", this degree of accuracy would soon disappear. Over time, brief increments of time will be gained or lost by these computer clocks, none of which are perfect nor gaining/losing at precisely the same rate. Eventually, these brief increments will mount up to differences of seconds or even minutes.

If there is even a small difference in the universal time on the clocks of the systems involved, the consequences are significant. If the originating DSA stamps an operation at 16:00:00 and has set a 15 second time-out, and the receiving DSA thinks the time is 16:00:20, the operation will experience "communications time out value exceeded" upon reaching the target DSA even if the communication path is instantaneous, which is unlikely.

Resolution

The solution was to have all the universal clocks in the distributed computers have the same time values. To accomplish this, Challenge infrastructure and application participants selected the Network Time Protocol (NTP) to set a single system time for the entire Challenge. This is an Internet standard method of ensuring equal clock values and free software is available on the Internet at:

> http://www.eecis.udel.edu/~ntp/ (for UNIX systems)
> ftp://ftp.drcoffsite.com (for Windows N/T)

For the latter site, send an e-mail to "access@drcoffsite.com" to obtain the ftp password necessary to establish your ftp session.

There are different stratum levels of time service. For example, the NTP primary time service servers are stratum 1. Since connecting to stratum 1 servers is only recommended if the time server will be serving 100+ hosts, participants elected a lower level of time service. The US and US Government DSAs were configured as stratum-3 NTP servers, and the Challenge participants can use them for time synchronization. The impact on system resources of running a time service was determined to be minimal.

It should be pointed out that there are other methods available for synchronizing computer clocks around the world, but NTP was readily available and satisfied the requirements of the Challenge.