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An LDAP/X.500 based distributed PGP Keyserver

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Agenda

- PKI and Directory
  - X.500
  - LDAP
- PGP Keyserver
  - The current PKSD and its problems
  - New concepts
- Directory based PGP keyserver
  - Standardization process
  - Status
  - Objectclasses

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PKI and Directory

The Burton Group:

Network Strategy Report, PKI Architecture, July 1997:
(Quoted after: S. Zeber, X.500 Directory Services and PKI issues, http://nra.nacosa.nato.int/pki/hdocs/pkiahwg30/index.htm)

" ... Customers should always consider PKI a directory-enabled set of services and infrastructure. Without directory services, PKI will be exponentially harder to implement and manage. Consequently, customers should't deploy PKI widely without an accompanying directory plan"

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Directory as Key Server Requirements

- Publishing medium for public keys and certificates
- Gets public keys from user
- Gets certificates from CA
- Documents revocation of keys/certificates (CRL)
- Documents status of a certificate at a specific time

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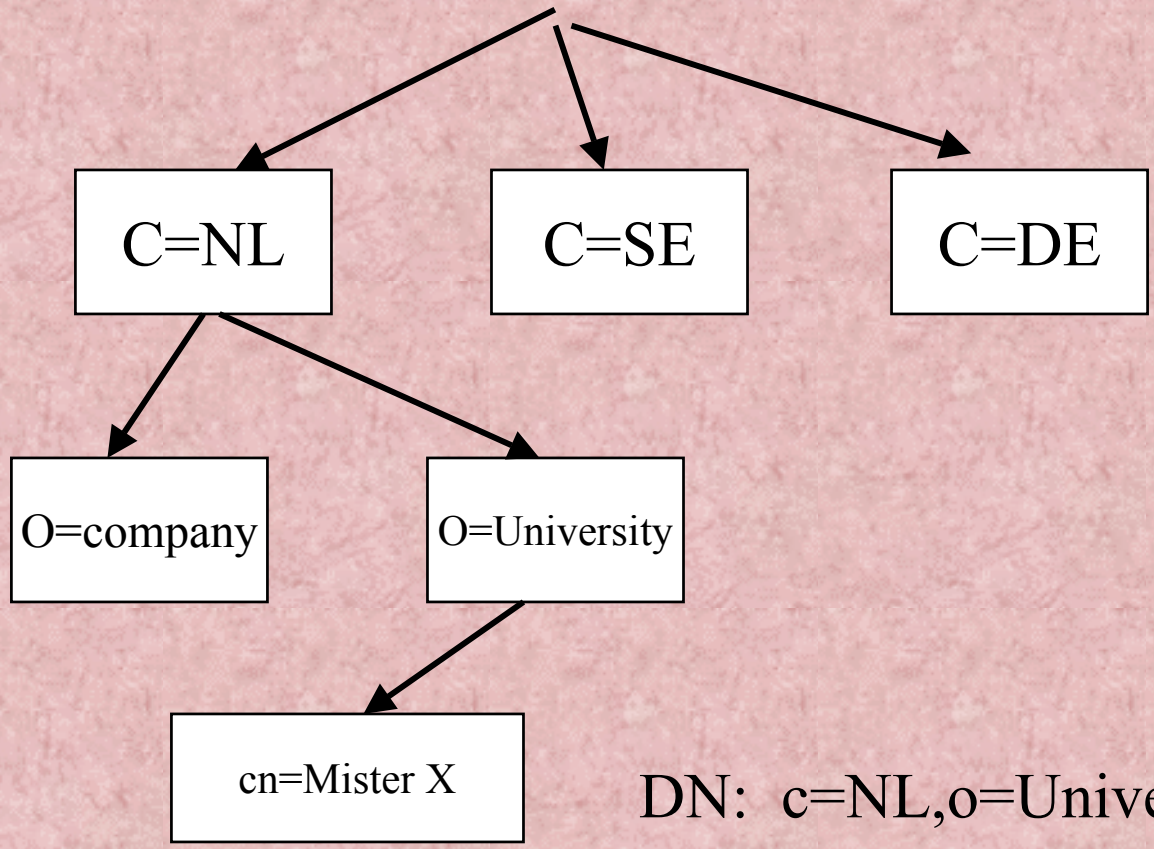
What is Directory?

- X.500 Database standard
- ISO/ITU v1: 1988, v2: 1993, v3: 1997, v4: 2000
- Worldwide distributed data
- All data accessible worldwide
- Hierarchical organized data tree
- Objectoriented design (inheritage of objectclasses)
- extensible data model - anything goes

Directory Information Tree (DIT)



DN: c=NL,o=University,cn=Mister X

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LDAP

- Lightweight Directory Access Protocol
- Current version: 3
- IETF standard (RFC 2251-2256)
- Not anymore only access protocol, but a full blown client server system
- All Directory implementations have LDAP interface (X.500 products, Novell NDS, M$ Active Directory)
- Lots of client applications have LDAP interface (mail user agents, browser, PGP software)

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PGP key server

- First only replication of pubring via email
- Marc Horrowitz Keyserver (PKSD)
  - Started 1995
  - Own database backend
  - Email and HTTP interface
  - Operational model (add, revoke, etc.)
  - Net of server
  - Every server has all keys
  - Server synchronisation via email

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PKSD Problems

- No distributed system: all keys on all server
- Permanent server synchronisation causes high bandwith usage
- Chaos when one server is down (bouncing emails)
- No guarantee that a key is replicated on all server
- Not scalable

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Problems of the Web of trust

- Most keys only selfsigned (=islands of trust)
- The web of trust is only existing for people belonging to certain inner circles
- Many users don’t know what they are signing
- Even at IETF Key signing parties there is no proof of identity

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New concepts for PGP key server

- PKSD with enhanced backend (Open Keyserver from Highware)
- Keyserver based on DNSSec (www.ietf.org/html-charter/dnssec-charter.html)
- Synchronisation via multicast (G. Baumer, Distributed Server for PGP Keys synchronised by multicast, www.vis.ethz.ch/~baumi/sa/thesis/thesis.html)
- Keyserver based on LDAP (PGP Certificate Server from NAI)

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LDAP PGP-Keyserver requirements

- Standardizes solution
  - data model
  - operational model
- Keys searchable by different criteria
- Certification path followable
- Key status retrievable

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Process of standardization

- 1994 Draft from Roland Hedberg
- 1994 proprietary solution in Tübingen
- Both models fail to include more than one certificate in a person's entry
- 1998 new initiative by DANTE
- DDS and University of Stuttgart take part in the discussion and announce an Internet Draft
- Roadmap: Draft in Summer 2000

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Status of LDAP PGP key server

- PGP test server based on LDAP:
  - ldap://as.directory.dfn.de:11010/l=PGP Keyspace??sub?(cn=*)
  - http://as.directory.dfn.de:11011
- Policy for a service
- Definition of a data model for PGP
- Definition of a format for CAs to send certificates
- Software for storing and retrieving certificates
- A user can store his key into the server via WWW formular

The Directory Information Tree for PGP

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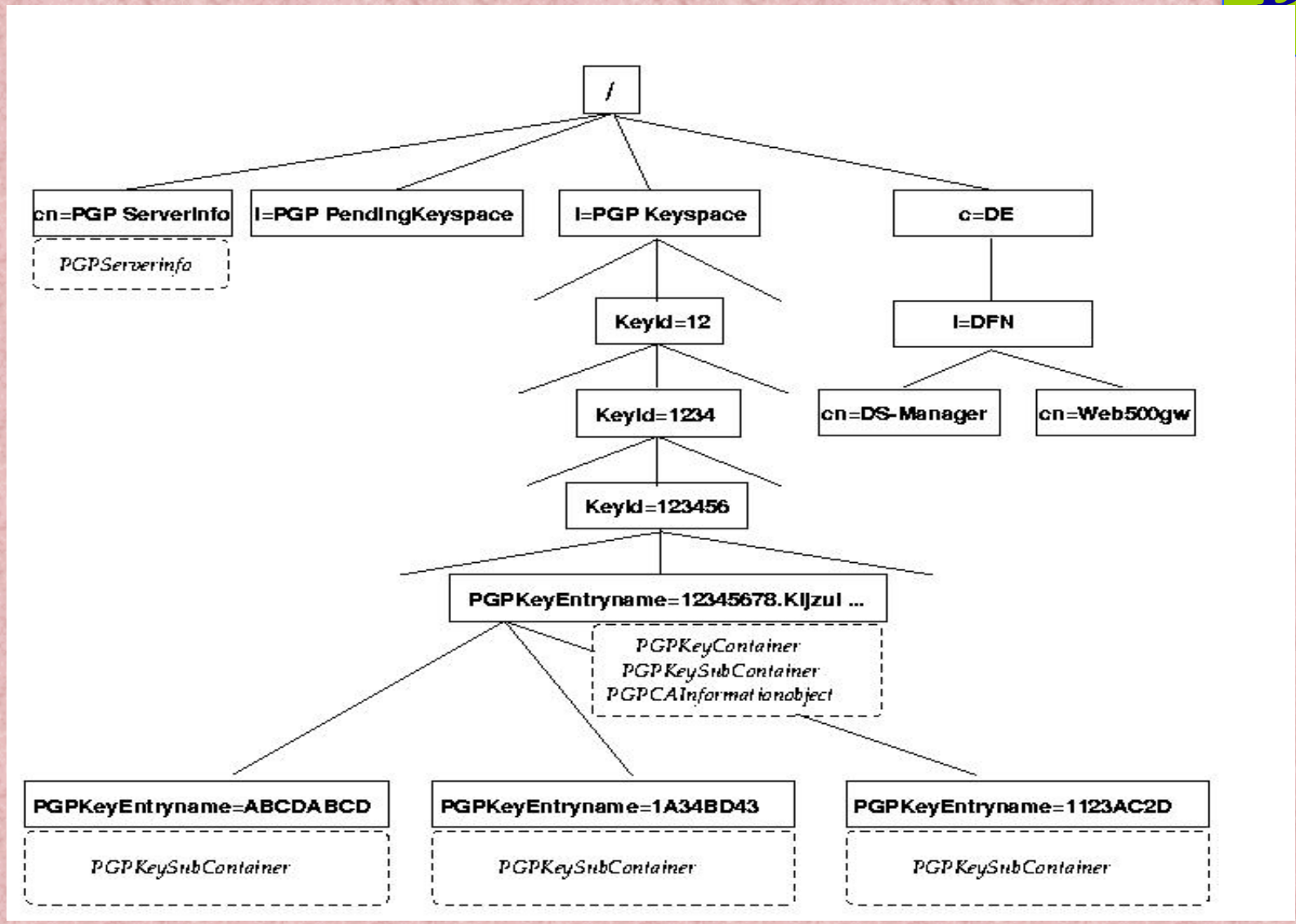

A PGP key displayed (1)

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File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: http://as:11011/MpGPKeyEntryName%3d094E0FCD.pwvNsr-1Geq4 What's Related

Members WebMail Connections BizJournal SmartUpdate Mktplace

AMBIX: Das DFN-E-Mail-Verzeichnis

Homepage Gesamtindex Hilfe zur Suche Hilfe zum Selbsteintrag

Hilfe

Gehe in das Verzeichnis von -> 094E0F

DFN-DIRECTORY, ROOT-CA-KEY (LowLevel: 1999-2000) <pgp-ca@directory.dfn.de>

UserID
DFN-DIRECTORY, ROOT-CA-KEY (LowLevel: 1999-2000) <pgp-ca@directory.dfn.de>
Schlüsseltyp
RSA
KeyID
094E0FCD
Schlüssellänge
01024
FingerPrint
1B 22 83 1B 07 3C 71 0F EA 60 C3 D1 12 33 14 03
Ascii-Armored Key (base64 encoded)

```
-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: 2.6.3i

mQCNAzblQ2oAAAEEAKr3jAKaX2fHSrXg0D/tcIRvLwt1I77IGAAzHaB/wBKAlh7v
mprCyUNyTFhIVN/QwkF+odma881FtiPKeI+cRv1P0HJUK9yFgTl8VBVTXBxrE21i
IeRw8IIxIWgQhbaMnr8VhivMp/IyPpA6L7PaztEtpz0FFbNYGnhacekJTg/NAAUR
```

A PGP key displayed (2)

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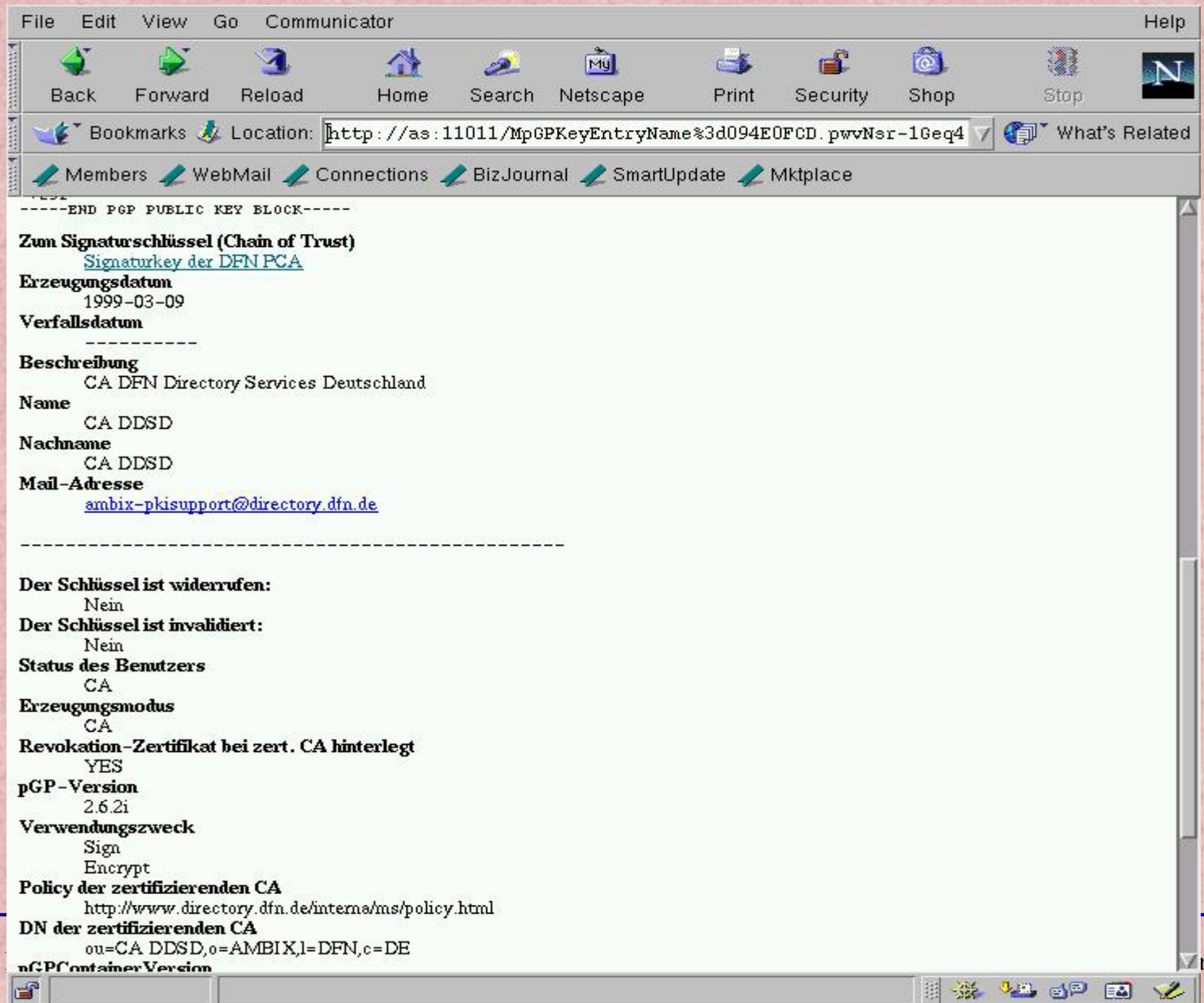

The DFN-PCA key

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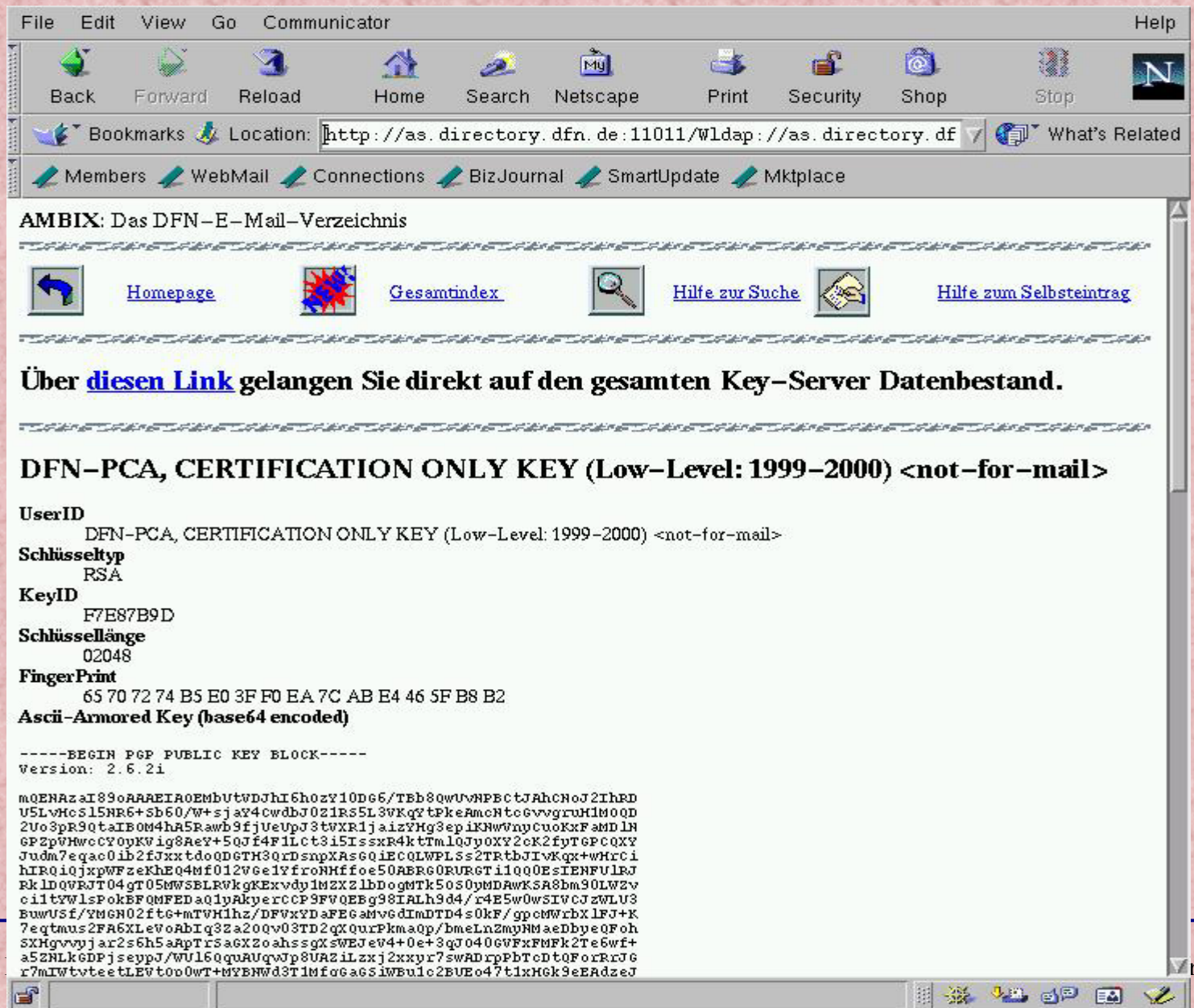

rectory services

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Objectclasses for PGP 1: pGPKeyContainer

- must contain:
  - pGPKeyEntryName (name of the entry);
  - pGPKey (ASCII-armored key)
  - pGPUserId; pGPKeyID; pGPFingerPrint
  - pGPKeySize; pGPKeyType
- may contain:
  - pGPKeyCreateTime; pGPKeyExpireTime
  - pGPKeyRevoked (0=valid, 1=revoked)
  - pGPKeyUsage
  - pGPUserDN (DN of the directory entry of the person)

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Objectclasses for PGP 2: cAInformationObject

- must contain:
  - cACertKeyLink / cACertKeyURL (DN / URL of the certifying key)
  - cADN / cAURL (DN / URL of the CA, or RA)
  - cAPolicy (URL of the CA's policy)
  - cACRLDN / cACRLURL (DN / URL of the CA's CRL)

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Objectclasses for PGP 3: pGPServerInfo

- must contain:
  - cn (name of the entry, always cn=pGPServerInfo)
  - baseKeySpaceDN (DN of the PGP keyspace subtree)
- may contain:
  - basePendingDN (DN of the keyspace for yet pending keys)

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Current problems

- PGP ServerInfo entry has to be directly underneath the root
- Current model is not similar to the X.509 Key storage model
- Will S/MIME win the race?

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Addresses and Partners

- DFN Directory Services
  - http://www.directory.dfn.de
  - mailto:dirco@directory.dfn.de
- DFN PCA
  - http://www.cert.dfn.de/dfn-pca
  - mailto:dfnpca@pca.dfn.de
- University of Stuttgart CA
  - http://ca.uni-stuttgart.de
  - mailto:info@ca.uni-stuttgart.de

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X.509: The classic (1988)

- "The Directory: Authentication Framework"
- Part of the OSI-Directory standard X.500
- Defines Data model, e.g.:
  - userCertificate; cACertificate
  - crossCertificatePair
  - certificateRevocationList
- Defines mechanisms for authentification
- Certificate includes DN of the user
- Certificate includes DN of the signing CA

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X.509v3 (1997)

- New extension mechanism
- Predefined extensions:
  - Information about key: identifier, usage, ...
  - Policy information: certificate policy, ...
  - User and CA extensions: alternative name, ...
  - Certification path constraints
- Lots of people see X.509v3 as independent from X.500
  - Problem: hypothetical DNs
  - No proof of uniqueness

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X.509v4 (2000)

- Draft version ready (May 11, 2000)
  - ftp://ftp.bull.com/pub/OSIdirectory/4thEditionTexts/X.509_4thEditionDraftV2.pdf
  - Press release: http://www.itu.int/ITU-T/itu-t_news/sg7_x509_press.htm
- Includes verification of certificate chains with CAs from different domains and hierarchies
- Enhancements in the area of certificate revocation
- New features in attribute certificates (AC)
- Defines usage of ACs for access control and authorization

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Applications of X.509 certificates

- Certificate based security on different levels:
  - Network Layer:
    - IPSec (Internet Protocol Security)
  - Transport Layer:
    - SSL (Secure Socket Layer) =
    - TLS (Transport Layer Security)
  - Application Level:
    - S/MIME (Secure Multipurpose Internet Mail Extensions) v3: patent free algorithms, mailing list support
    - PGP (Pretty Good Privacy), since version 6

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IETF WG PKIX

- Defines an Internet PKI on basis of X.509 certificates
- Supports the following IETF security protocols:
  - S/MIME
  - TLS (=SSL)
  - IPSec
- Status:
  - 9 RFCs
  - 21 Internet Drafts
  - Overview: <draft-ietf-pkix-roadmap-05.txt>

PKIX and certificate profiles

- **RFC 2459 redrafted: <draft-ietf-pkix-new-part1-00.txt> defines:**
  - **Certificate (X.509v3 standard fields and standard extensions plus one private extension for authority information access, for e.g. validation service)**
  - **CRL (X.509v2 standard fields, and standard extensions)**
  - **Certificate path validation process, basic and extending**
- **<draft-ietf-pkix-acx509prof-02.txt> defines:**
  - **Attribute certificate profile for standard fields and extensions**
  - **additional attribute types**
  - **Attribute certificate validation**
  - **revocation**

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PKIX and certificate profiles (contd.)

- <draft-ietf-pkix-qc-03.txt> defines:
  - Qualified Certificate
    - as prescribed by some governmental laws
    - owner is natural person
    - unmistakable identity
    - only non-repudiation as key usage
    - ...

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PKIX LDAPv2 schema

- RFC 2587 “Internet X.509 Public Key Infrastructure LDAPv2 Schema”, defines:
  - Objectclass pkiUser with attribute userCertificate
  - Objectclass pkiCA with attributes cACertificate, certificateRevocationList, authorityRevocationList, crossCertificatePair
  - Objectclass cRLDistributionPoint with attributes cn, certificateRevocationList, authorityRevocationList, deltaRevocationList
  - Objectclass deltaCRL with attribute deltaRevocationList

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PKIX operational protocols

- LDAPv2: RFC 2559 defines:
  - LDAP repository read
  - LDAP repository search
- LDAPv3: <draft-ietf-pkix-ldap-v3-01.txt> defines:
  - Which v3 features are needed in PKIX
  - attributeCertificate
  - certificate matching rules
- FTP/HTTP: RFC 2585
- Limited Attribute Certificate Acquisition Protocol (LAAP) <draft-ietf-pkix-laap-00.txt>

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PKIX and certificate validation

- Simple Certification Verification Protocol (SCVP) <draft-ietf-pkix-scvp-01.txt>
  - Client can offload certificate validation to a dedicated (trusted) server (validity of certificate and certification path)
- Online Certificate Status Protocol (OCSP) RFC 2560
  - determination of current status of a certificate without the use of CRLs
  - question contains cert id and time
  - answer contains: “revoked”, “notRevoked” or “unknown”
- OCSP Extension <draft-ietf-pkix-ocspx-00.txt>
  - allows client to delegate processing of certificate acceptance functions to a trusted server

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LDAP work on X.509: Data model

- **LDAP Object Class for Holding Certificate Information <draft-greenblatt-ldap-certinfo-schema-02.txt>**
  - **Introduces Objectclass certificateType**
  - **enables client to retrieve only those certificates that it really wants**
  - **contains attributes: typeName, serialNumber, issuer, validityNotBefore, validityNotAfter, subject, subjectPublicKeyInfo, certificateExtension, otherInfo**

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LDAP work on X.509: TLS

- **LDAPv3 Extension for Transport Layer Security** <draft-ietf-ldapext-ldapv3-tls-06.txt>
  - Extended request/response for Start TLS operation
- **Authentication Methods** <draft-ietf-ldapext-authmeth-04.txt>
  - Includes (as SHOULD) certificate-based authentication with TLS
  - Client uses Start TLS operation
  - Server requests client certificate
  - Client sends certificate and performs a private key based encryption
  - Client and server negotiate ciphersuite with encryption algorithm
  - Server checks validity of certificate and its CA
  - Client binds with SASL “EXTERNAL” mechanism