DECnet-Plus und TCP/IP

DECUS IT - Symposium

4. April - 8. April 2005

Düsseldorf

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Evolution of DNA

DNA Phases

- Phase I
  - 1976 PDP-11 RSX
  - Program to program (task to task) communication
  - File Transfer
  - Typical customer was NOT an end user
  - Maximum network size of 16 point-to-point nodes

- Phase II
  - 1978 VAX 11/780 VMS V1, RSX, RT-11
  - Remote file access
  - Viewing and listing directories
  - Network management
  - Maximum network size of 64 point-to-point nodes
  - Provided a means of monitoring, testing and controlling the network

- Phase III
  - 1980
  - Adaptive routing
  - Network terminals (e.g. SET HOST)
  - Multipoint lines
  - CCITT X.25
  - Record access
  - Down-line loading
  - Maximum size of network was 255 nodes

Evolution of DNA

- Phase IV
  - 1983
  - Incorporated LAN technology into DECnet
  - Ethernet-LANs
  - LAT-Support, Terminalserver
  - with VMS 4.0: VAXcluster
  - Token Ring Support for Q-Bus
  - SNA-Gateway
  - Implementing OSI with separate Products: VOTS, OSAK, FTAM, X.400, ...
  - Maximum size of network ~64.000 nodes
- Phase V
  - 1988 IBM announced SAA
    Digital announced DNA Phase V with full support of the OSI architecture model
    NSAP max. 20 bytes
  - 1991
    VAX Extensions for VAX/VMS (Wave 1)
    VAX P.S.I. V5
    still remaining NCP
    DECnet/OSI for Ultrix
  - 1992 DECnet/OSI Wave 2
    full NCL-Management
  - 1993 Wave 3
    DNA IV applications over OSI Transport (TP4)
    DECnet/OSI for Digital UNIX
  - 1996
    DECnet-Plus for OpenVMS V7.1 and Digital UNIX V4.0

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What comprises DECnet-Plus ?

- **DNA Phase IV, complete stack including**
  - DNA IV Applications
  - DNA IV Routing
  - DNA IV Datalinks (DDCMP etc.)
- **OSI (Complete Stack, Layers 1-7)**
  - OSI Applications (FTAM, VTP)
  - OSI Transport (TP0, TP2, TP4)
  - OSI Routing (ISO 8473, ISO 9542, ISO 10589)
  - OSI Datalinks (ISO 8802.3, ISO 8802.2, ...)
  - OSI CONS (X.25, ISO 8208, ISO 7776)
- **DNA Phase IV Applications over TP4**
- **DNA IV - OSI Interworking**
  - Phase IV Router with V Router
  - Phase IV and V Router with IV and V End Systems
- **“DECnet over TCP/IP”**

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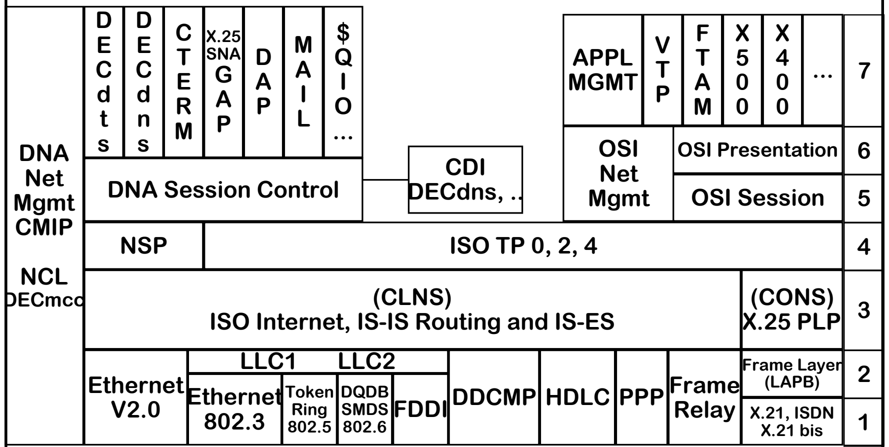
The Double-Headed Monster



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OSI Standards

Reference Model of Open Systems Interconnection

ISO 7498-1 CCITT X.200	ISO 7498-2 CCITT X.800	ISO 7498-3 CCITT X.650	ISO 7498-4 CCITT X.700
Basic Reference Model	Security Architecture	Naming and Adressing	Management Framework

ISO 7498 describes:

1. 7-layer-architectured-model
2. abstract description of the layers and services
3. Protocols of the layers (entities)

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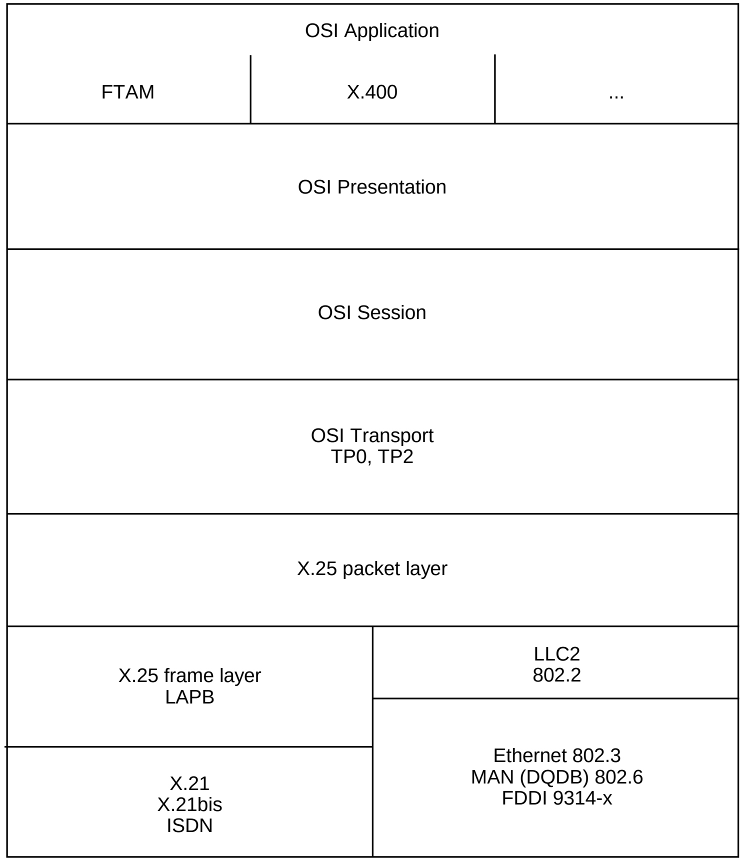
OSI Applications over CONS



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Network Layer

- CLNS: ISO Internet Protocol 8473
- CONS: OSI Transport directly over X.25 PLP over X.25 frame layer or LLC2
- Null Internet
- Routing: IS-IS (Link State Routing LSR)
  ES-IS
  DNA IV-routing (Routing Vector Routing (RVR)
  = Distance Vector Routing)
- Adaptive Routing
- Routing is based on costs (Metric)
- ES = End System
- IS = Intermediate System (Router)
- L1-routing
- L2-routing (area routing)
-

L1	L2
RVR	RVR
RVR	LSR
LSR	RVR
LSR	LSR

- most important rule: within an area only one algorithm
- for mixed domains on L2:
  Interphase links with static routes (Reachable Address Tables)

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ES-IS Protocol

ISO 9542 - ES-IS PROTOCOL

Used in conjunction with ISO 8473 (ISO 9542 is meaningless without ISO 8473).
Supported by all Phase V nodes.
ISO 9542 supports automatic configuration of adjacent node addresses.

- End systems identify adjacent intermediate systems
- Intermediate systems (IS) identify adjacent end systems (ES) on LAN and WAN, and identify adjacent IS on WAN.
  - Adjacent IS on LAN are found by listening for IS-IS Hello be used.
- When an adjacent WAN IS is found, then IS-IS Hello will be used.
- IS informs ES of a *better* path.
- ES can operate on a LAN, and without static tables.
- ES can autoconfigure their area address from an adjacent IS.

Only the following three extra message types are defined:

- ES Hello
- IS Hello
- Redirect

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IS-IS Protocol

IS-IS PROTOCOL - ISO 10589 WITH EXTENSIONS

The IS-IS protocol is supported by routers (IS) and not by end systems (ES).

- The original IS-IS protocol in DNA Phase V Routing was Digital proprietary.
  - The core of this original specification was taken as the base for ISO 10589
  - ISO 10589 does not include multiprotocol routing, but has been extended by other specifications (for example, by RFC1195) to include integrated multiprotocol routing.
  - DNA Routing (Integrated IS-IS) is a superset of ISO 10589
- DNA Routing has been modified to ensure that implementations conform to ISO 10589.
- The IS-IS protocol is used by intermediate systems (routers) to exchange information about other nodes in the network
  - IS are informed of the existence of nonadjacent nodes
  - IS can determine the best (least cost) path to other nodes
- Phase V routing algorithm
  - Link State Routing (LSR), same as that used in ISO 10589
  - LSR defines the Phase V IS-IS messages (link state packets) to exchange, and the algorithm to calculate the least cost path
- Phase IV routing algorithm
  - Routing Vector Routing (RVR)
  - There is no ISO standard for this protocol (it is Digital proprietary)
  - Defines different messages and algorithm
  - Supported by Phase V routers for interoperability with Phase IV routers

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IS-IS Protocol

Hierarchical Routing:

Phase V Routing is hierarchical (similar idea to Phase IV)

A network may be divided into DECnet areas as follows:

- Level 1 (L1) routers route messages within their own area.
- Level 2 (L2) routers (known as area routers) can route messages from area to area.
  - Level 2 routers also perform L1 routing within their own area
  - On a Level 2 router it is possible to set a circuit to be L2 only. When this is done, the circuit will only be used to route messages between L2 routers, and will not route to L1 routers or to ES. This is a new feature.

Digital Router and Gateway Products

- **WANrouter 100/500 (not longer supported)**
- **X25 Gateway (not longer supported)**
- **WANrouter 90**
- **WANrouter 250**
- **DECnis 500/600**
- **DECbrouter 90 (Cisco)**
- **RouteAbout-Family (Proteon)**
- **with VMS 7.1:**
  host-based routing is back for VAX and AXP

Transport Layer

NSP (Network Service Protocol)

Overview

NSP is a Digital proprietary protocol that is also used in earlier phases of DNA.

- The version of NSP used in DNA Phase V includes a number of relatively minor enhancements over earlier versions of NSP.
- Backward compatibility with earlier versions is assured.

NSP provides a connection-oriented transport service.

- In DNA Phase V the connections are referred to as *transport connections* (TC). Earlier phases of DNA referred to them as *logical links*.

NSP Functions

The major functions of NSP are:

- Connection establishment
- Connection release
- Data transfer and flow control
- Segmentation and reassembly
- Error detection and recovery

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OSI Transport

- The OSI Transport is layer 4 of the OSI Network Reference Model.
  - Provides transparent transfer of data between session entities and relieves them from any concern with the detailed way in which reliable and cost-effective transfer of data is achieved.
  - The OSI Transport makes use of the services of the Network Layer (layer 3).
  - TPDU (Transport Protocol Data Units) are the untis of data that the Transport Layer exchanges (transmits and receives) over the interface with the Network Layer.
  - From the Network Layer side of this interface they appear as NSDUs (Network Service Data Units).
- The OSI Transport provides services to the OSI Session Layer and to the DNA Session Control Layer.
  - TSDU (Transport Services Data Unit) are the untis of data that the Transport Layer exchanges with its user.
  - From the OSI Session Layer side of the interface they appear as SPDUs (Session Protocol Data Units).
- **ISO Standards**
- ISO 8072 - OSI Transport Service Definition
- ISO 8073 - OSI (connection-oriented) Transport Protocol Definition
  - Transport classes - Five classes defined for ISO 8073 Transport
    Class 0 (TP0), Simple Class
    Class 1 (TP1), Basic Error Recovery Class
    Class 2 (TP2), Multiplexing Class
    Class 3 (TP3), Error Recovery and Multiplexing Class
    Class 4 (TP4), Error Detection and Recovery Class
  - ISO 8602 - OSI (connectionless) Transport Protocol Definition
  - not architected for DNA and not implemented by Digital

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OSI Transport

The functions of OSI Transport are similar to those of NSP. Some of the transport classes support only subsets of the full functionality.

- Connection establishment
  - Supported by all transport classes
  - Negotiates the transport class to be used for the connection (among other responsibilities
- Connections release
  - Supported by all transport classes, although there is no explicit release in Class 0
- Error detection and recovery
  - Not supported by Class 0 or 2
  - Error recovery supported by Class 1 and 3
  - Error detection and recovery supported by Class 4
- Data transfer and flow control
  - All classes support data transfer, although Class 0 does not support expedited data.
  - Transport level flow control is utilized in Classes 3 and 4, and is optional in Class 2. (It is not available in Class 0 and 1.)
  - Segmentation and reassembly
  - All classes support segmentation and reassembly.

OSI Transport Implementations in DECnet-PLUS

- OSI Transport operates over CONS
  - Digital implements CONS in the PSI and WANDD products, which implement the X.25 packet-level protocol for operation over WAN (LAPB(E)) and LAN (LLC2).
  - Digital supports the use of TP0, TP2 and TP4 over CONS.
- OSI Transport operates over CLNS
  - Digital implements CLNS (in Phase V) as DNA IV Routing in DECnet products.
  - Digital supports only the use of TP4 over CLNS.

NOTE
DNA Routing may run over X.25 networks, but this is still a CLNS service.

DNA Session Control

Maps Node Names to Addresses

DECnet/OSI maps from names to addresses for an outgoing connection and from addresses to names for an incoming connection.

- Phase V Session Control uses CDI to store the information. Phase IV uses a local database on each node.
- Phase IV performs a simple name to address translation. Phase V additionally support:
  - Multiple addresses, for example, several NSAPs.
  - Storage and retrieval of protocol stack information, for example, to select NSP or OSI TP4
    - The protocol stack and address information is stored in the DECdns attribute DNA$Towers. This consists of ordered-by-layer protocol Ids and corresponding addresses. For example:

(Session Control ID + Object Number) + (TP4+TSAP) + (Routing ID+NSAP)

NOTE

Protocol stack information is held only for the Network Layer and above. The data link is selected by the Network Layer.

OSI Session

- OSI Session forms layer 5 of the OSI Network Reference Model.
- OSI Session makes use of the services of OSI Transport (Layer 4).
- OSI Session provides services to the OSI upper layers. The normal user of these services is the OSI Presentation Layer.

ISO Standards

- ISO 8326 is the OSI Session Service definition.
- ISO 8327 is the OSI Session Protocol definition
- ISO 9548 is the OSI Connectionless Session Protocol definition

Functionality of OSI Session Compared to DNA Session Control

DNA Session Control and OSI Session are similar to the extent that they each define layer 5 of their corresponding protocol stacks.
In most other respects these protocols are different.

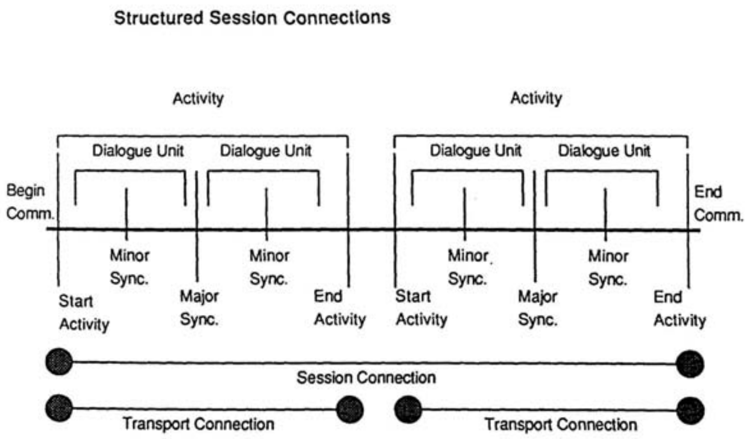
- DNA Session Control runs over either NSP or OSI Transport Class 4, which make use of DNA Routing (CLNS) at the Network Layer.
- OSI Session cannot run over NSP, but can run over any supported OSI Transport Class, and over whichever network over TP4 over DNA Routing (CLNS).
- - DNA supports TP0 and TP2 over CONS and TP4 over either CONS or
  CLNS, so it is possible to run OSI Session over TP4 over DNA Routing (CLNS).

Most of the functionality of OSI Sessionis involved in providing services during the data transfer phase.

- These services allow the session user to structure the exchange of messages, so that the messages involved in providing a particular user function (for example, a transaction) are grouped together.
- The session services, additionally, allow the session user to:
  - Resynchronize the user function
  - Abort the user function
  - Suspend the user function for later resumption

Structure of Communication between Processes

- Session communications may be structured or unstructured.
- Wether a session connection is structured and the extent of the structuring is determined by the functional units selected during the establishment of the connection.



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OSI Presentation layer

The Presentation Layer provides for a common representation to be used between application entities. This layer relieves the application entities of any concern for common representation of information. It provides them with syntax independence.

- Service definition - ISO 8822
- Protocol definition
  - Connection-orientated - ISO 8823
  - Connectionless - ISO 9576
- Abstract syntax notation
  - ASN.1 notation - ISO 8824
  - ASN.1 encoding rules - ISO 8825
- Characteristics
  - Negotiation and selection of syntax
  - Functional units
  - Syntax
    - Concrete
    - Transfer
    - Abstract
  - Presentation context

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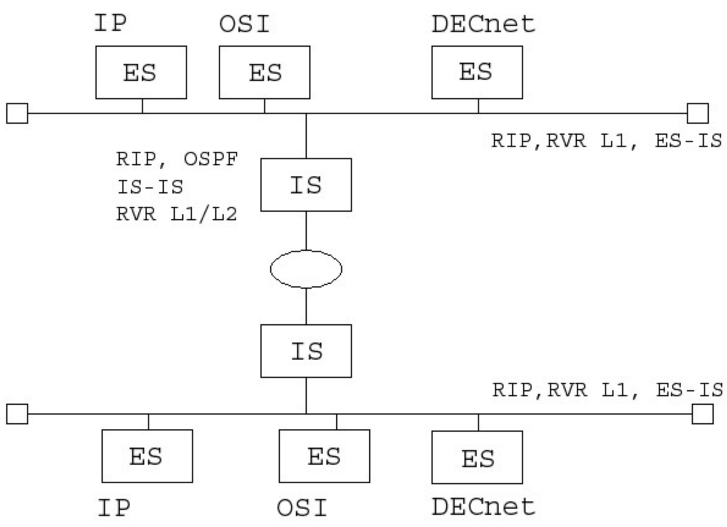
DECnet-Plus over IP

LAN´s mit IP-, OSI- und DECnet-Applikationen

1) Router müssen sämtliche Protokolle routen.



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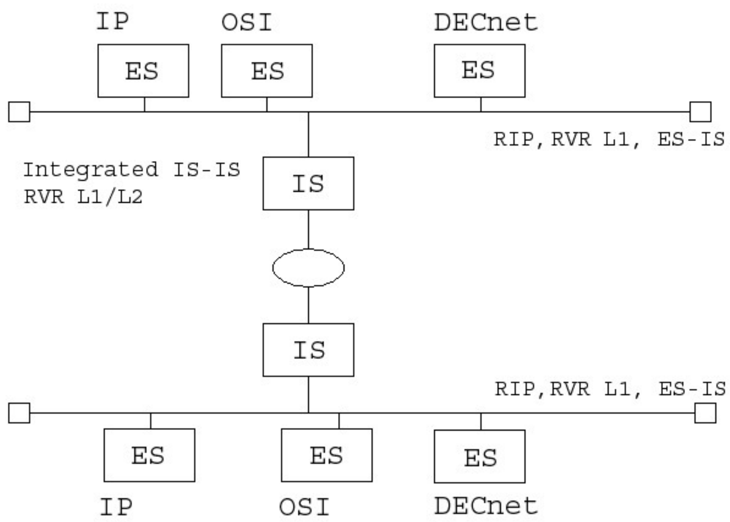
2) Integrated IS-IS ISO 10589 RFC 1195
IS-IS Link State Packets übertragen IP Routing Informationen



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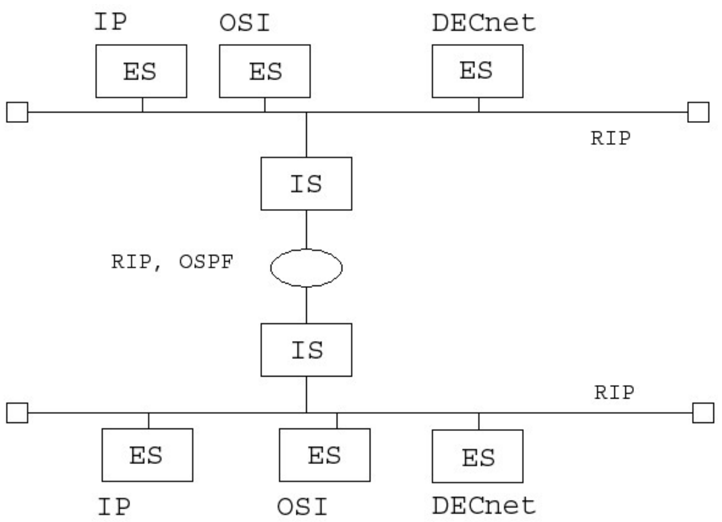
3) RFC 1006: OSI-Applikationen über TCP/IP
RFC 1859+RFC 2126: DECnet-Applikationen über TCP/IP



DECnet-Plus over IP

- **Requirements:**

- DECnet/OSI V6.x or DECnet-Plus for OpenVMS
- DECnet/OSI V3.2B or DECnet-Plus for Digital Compaq UNIX
- TCP/IP stack that supports the PWIP driver (only OpenVMS)
- OSI Transport utilizes the RFC1006 and RFC1006plus templates
- in the Session Control Naming Search Path should be the fully qualified host name for DNS/BIND included so that IP host name to IP address translation can take place .

RFC1006

The OSI-Applications over TCP/IP

OSI Applications				
FTAM	VT	X.400	X.500	...
OSI Presentation ASN.1				
OSI Session				
OSI Transport TP0				
RFC1006				
TCP				
IP				
Network Access				

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RFC1006+RFC1859+RFC2126

The DNA-Applications over TCP/IP

DNA-Applications					
DAP	CTERM	Mail	Phone	$QIO	...
Session Control CDI Common Directory Interface	Global Namespace Local Naming DNS / BIND				
OSI Transport TP2					
RFC 1006+					
TCP					
IP					
Network Access					

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DECnet-Plus over IP

```
show address
!
! Node 0
! at 1999-04-07-10:41:38.027+02:00Iinf
!
! Identifiers
!
!     Address                                   =
!         {
!             (
!             [ DNA_CMIP-MICE ] ,
!             [ DNA_SessionControlV3 , number = 19 ] ,
!             [ DNA_OSItransportV1 , 'DEC0'H ] ,
!             [ DNA_OSInetwork , 49::00-01:AA-00-04-00-5E-04:21
!                                 (DITECEDU:.MUC.NET.UFV094) ]
!             ) ,
!             (
!             [ DNA_CMIP-MICE ] ,
!             [ DNA_SessionControlV2 , number = 19 ] ,
!             [ DNA_OSItransportV1 , 'DEC0'H ] ,
!             [ DNA_IP , 10.2.0.94 ]
!             ) ,
!             (
!             [ DNA_CMIP-MICE ] ,
!             [ DNA_SessionControlV3 , number = 19 ] ,
!             [ DNA_NSP ] ,
!             [ DNA_OSInetwork , 49::00-01:AA-00-04-00-5E-04:20
!                                 (DITECEDU:.MUC.NET.UFV094) ]
!             )
!         }
!
!
```


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DECnet-Plus over IP

```
show osi transport template *
!
! Node 0 OSI Transport Template DEFAULT
! at 1999-04-07-10:42:09.267+02:00Iinf
!
! Identifiers
!
!     Name                                        = DEFAULT
!
!
! Node 0 OSI Transport Template osit$loop_clns
! at 1999-04-07-10:42:09.267+02:00Iinf
!
! Identifiers
!
!     Name                                        = osit$loop_clns
!
!
! Node 0 OSI Transport Template osit$loop_cons
! at 1999-04-07-10:42:09.267+02:00Iinf
!
! Identifiers
!
!     Name                                        = osit$loop_cons
!
!
! Node 0 OSI Transport Template osit$rfc1006
! at 1999-04-07-10:42:09.267+02:00Iinf
!
! Identifiers
!
!     Name                                        = osit$rfc1006
!
!
! Node 0 OSI Transport Template osit$rfc1006plus
! at 1999-04-07-10:42:09.267+02:00Iinf
!
!
! Identifiers
!
!     Name                                        = osit$rfc1006plus
!
!
! Node 0 OSI Transport Template mta_cons
! at 1999-04-07-10:42:09.267+02:00Iinf
!
! Identifiers
!
!     Name                                        = mta_cons
!
```


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DECnet-Plus over IP

```
show osi transport template osit$rfc1006 all
!
! Node 0 OSI Transport Template osit$rfc1006
! at 1999-04-07-10:42:23.957+02:00Iinf
!
! Identifiers
!
!     Name                                  = osit$rfc1006
!
! Characteristics
!
!     Keepalive Time                        = 60
!     Retransmit Threshold                  = 8
!     Initial Retransmit Time               = 5
!     CR Timeout                            = 30
!     ER Timeout                            = 30
!     Network Service                       = RFC1006
!     Security                              = <Default value>
!     Classes                               =
!         {
!            0
!         }
!     Checksums                             = False
!     Maximum NSDU Size                     = 2048
!     Expedited Data                        = True
!     CONS Template                         = "OSI Transport"
!     Use CLNS Error Reports                = True
!     Acknowledgement Delay Time            = 1
!     Local NSAP                            = <Default value>
!     CLNS Inactive Area Address            =
!         {
!         }
!     Inbound                               = True
!     Loopback                              = False
!     Send Implementation Id                = True
!     Extended Format                       = True
!     Network Priority                      = 0
!     Send Preferred maximum TPDU size      = True
!     Send Request Acknowledgement          = True
!     RFC1006 Port Number                   = 102
!
```


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DECnet-Plus over IP

```
show osi transport template osit$rfc1006plus all
!
! Node 0 OSI Transport Template osit$rfc1006plus
! at 1999-04-07-10:42:31.817+02:00Iinf
!
! Identifiers
!
!     Name                                  = osit$rfc1006plus
!
! Characteristics
!
!     Keepalive Time                        = 60
!     Retransmit Threshold                  = 8
!     Initial Retransmit Time               = 5
!     CR Timeout                            = 30
!     ER Timeout                            = 30
!     Network Service                       = RFC1006
!     Security                              = <Default value>
!     Classes                               =
!         {
!            2
!         }
!     Checksums                             = False
!     Maximum NSDU Size                     = 2048
!     Expedited Data                        = True
!     CONS Template                         = "OSI Transport"
!     Use CLNS Error Reports                = True
!     Acknowledgement Delay Time            = 1
!     Local NSAP                            = <Default value>
!     CLNS Inactive Area Address            =
!         {
!         }
!     Inbound                               = True
!     Loopback                              = False
!     Send Implementation Id                = True
!     Extended Format                       = True
!     Network Priority                      = 0
!     Send Preferred maximum TPDU size      = True
!     Send Request Acknowledgement          = True
!     RFC1006 Port Number                   = 399
!
```


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DECnet-Plus over IP

```
sho session control naming search path
!
! Node 0 Session Control
! at 1999-04-07-10:47:11.287+02:00Iinf
!
! Characteristics
!
!     Naming Search Path                =
!         {
!             [
!             Directory Service = DECdns ,
!             Template = "*"
!             ] ,
!             [
!             Directory Service = DECdns ,
!             Template = "DITECEDU:*"
!             ] ,
!             [
!             Directory Service = DECdns ,
!             Template = "DITECEDU:.MUC.NET.*"
!             ] ,
!             [
!             Directory Service = DECdns_Synonym ,
!             Template = "DITECEDU:.DNA_NodeSynonym.*"
!             ] ,
!             [
!             Directory Service = Domain ,
!             Template = "*"
!             ] ,
!             [
!             Directory Service = Domain ,
!             Template = "*.ditec.de"
!             ]
!         }
!
```


Neue Features für DECnet-Plus in OpenVMS 7.3-2

DNS/BIND kann erster bzw. einziger Namespace (Directory Service) sein.

DECdns läuft nun über TCP/IP gemäß RFC 1859, d.h. IP address towers können in DECdns verwaltet werden.

DECdtss läuft nun in reiner IP-Umgebung. Global DTSS-Server kann von einen BIND-Server oder vom DECdns-Server über TCP/IP gelesen werden.

DECnet-Plus unterstützt „LAN failover sets".

NCL SHUT ALIAS PORT Clustermember erlaubt keine weiteren ALIAS-Verbindungen.

Neue Features für DECnet-Plus in OpenVMS 8.2

-FTAM wird noch nicht unterstützt
für OpenVMS I64 Systeme

-sys$manager:isis$configure.com
ermöglicht
Link State Routing IS-IS !!!!

-Help Updates

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Zeitsynchronisation DECdts

- DECdts ist ein netzwerkverteilter Service für OpenVMS und Tru64 Unix zur Synchronisation der Uhren im Netz LAN und WAN basierend auf einem Client/Server Modell

-Jeder Server bietet die Zeit an Clients und Applikationen durch Clerks an.

-DECdts erlaubt den Anschluss von externen Uhren, z.B. Hopfuhr.
-Lokale Server arbeiten im LAN
-Globale Server übermitteln die Zeit in WANs
-Courierserver vermitteln dazwischen

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Zeitsynchronisation NTP

-Network Time Protocol Version 3 RFC1305 March 1992

-TCP/IP Services for OPENVMS V5.4 unterstützt NTP 4.2

-NTP ermöglichst externe Uhren, z.B. im Internet ptbtime1.ptb.de

-Nachteile von NTP im Vergleich zu DECdts: keine Kenntnisse von Sommer/Winterzeit

Workaround: Systemparameter AUTO_DLIGHT_SAV ab OpenVMS 7.3-2

-Zeitausgleich wird sehr langsam durchgeführt 1 Sekunde pro 2000 Sekunden

-Workaround: NTP 4.2 1 Sekunde pro 20 Sek

Zeitsynchronisation NTP

NTP kann Zeit nicht abrupt auf aktuellen Wert einstellen

Workaround: NTP im Startup stoppen, Zeit synchronisieren und NTP wieder starten, verwende dazu NTPD Kommandos

Fazit: Kunden waren mit reiner NTP Konfiguration nicht zufrieden, gerade im Cluster oder Hot Standby

Lösung: lies Zeit von externen NTP Server in DTS Server ein und synchronisiere sie im DECnet-Plus.
Verwende dazu DTSS$PROVIDER.EXE in SYS$EXAMPLES
Zur Ausfallsicherheit konfiguriere 2 DECdts Server im LAN

Beste Kundenzufriedenheit in allen Fällen !!