ngmn
the engine of broadband
wireless innovation

A Network Data Layer Concept for the Telco Industry

next generation mobile networksA

A network data layer concept for the telco industry

by NGMN Alliance

Version: **Date:** **Document Type:** **Confidentiality Class:** Authorised Recipients: (for CR documents only)	**V1.0** **17-08-2018** **Final Deliverable (approved)** **P - Public**

Project:	**Supported by NGMN Projects NWMO, SBA and E2E Architecture Framework**
Editors / Submitters:	**Andreas Hörnes, Deutsche Telekom; Sven Langer, Deutsche Telekom**
Contributors:	**Diego Lopez, Telefonica; Tao Sun, China Mobile; Joong-Gunn Park, SK Telecom; Mark Henry, BT,**
Supporters:	
Approved by / Date:	**NGMN Board, 31st August 2018**

Commercial Address:
ngmn Ltd.,
Großer Hasenpfad 30
60598 Frankfurt • Germany
Phone +49 69/9 07 49 98-0
Fax +49 69/9 07 49 98-41

Registered Office:
ngmn Ltd.,
Reading Bridge House • George Street • Reading •
Berkshire RG1 8LS • UK
Company registered in England and Wales n. 5932387,
VAT Number: GB 918713901

Table of Contents

1 Introduction 3

2 A key feature of a cloud native architecture: 5

3 Benefits & use cases enabled by the externalization of various types of data................. 9

4 Architecture cornerstones...11

5 Proof points...12

6 Conclusion 12

1 Introduction

Moving towards software-centric cloud deployments, Network Functions Virtualization is one of the most important technology transformations in the telecommunication industry.

In today's digital age, Network Service Providers[1] (NSP) are competing with OTT content providers and virtual NSPs. The combination of severe competition and the need to keep pace with technology evolution (e.g. 5G, industrial Internet) forces companies to improve operational efficiency at lowest cost.

Cloud-optimized network architectures facilitate to automate processes and to take most advantage of cloud mechanisms such as redundancy, auto-scaling and self-healing.

Though operational efficiency is strongly depending on how network data is managed.

Typically, network data is distributed across multiple network functions and managed within silos leading to many inefficiencies. For example:

- high network complexity through multiple data provisioning points,
- data duplication and the risk of data inconsistencies,
- heterogeneous data storage and management functions,
- heterogeneous data availability and resiliency measures,
- scalability at the cost of increased network function complexity and
- multiple network data sources for analytics.

Cloudified network functions leverage the principles of a multi-tier architecture with a clear separation of data processing (application logic) and data storage utilizing a distributed cloud database (cf. figure 1).

This decoupling enables:

- simplified and harmonized VNF architecture,
- independent scaling of data storage and processing functions,
- reliable cloud-based resilience,
- increased operational flexibility and simplification
- reduction of total cost of ownership.

[1] Traditionally referred to as Telcos or operators

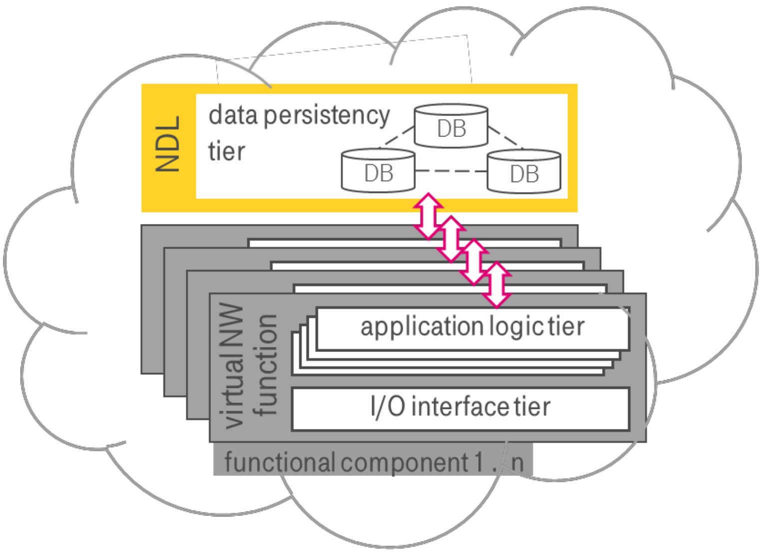

Figure 1: Strict separation of data storage and data processing.

On the market, many different database solutions are available. All of these are implemented to serve special use cases, but possess solution specific shortcomings like:

- outliers in response times up to seconds,
- limited data redundancy-, replication- and data consistency methods,
- limited data recovery options,
- single key and unstructured data restrictions or
- exposing their implementation to the client.

Developers of network functions should be enabled to focus on the application logic by profiting from and relying on data services. In doing so, developers no longer need to concentrate on different data management techniques and their respective characteristics.

NDL implemented as one logical entity provides a rich set of NSP-grade cloud database services (cf. figure 2) to limit the variance of database solutions and avoid data inconsistencies by data consolidation while further reducing operational complexity and total cost of ownership.

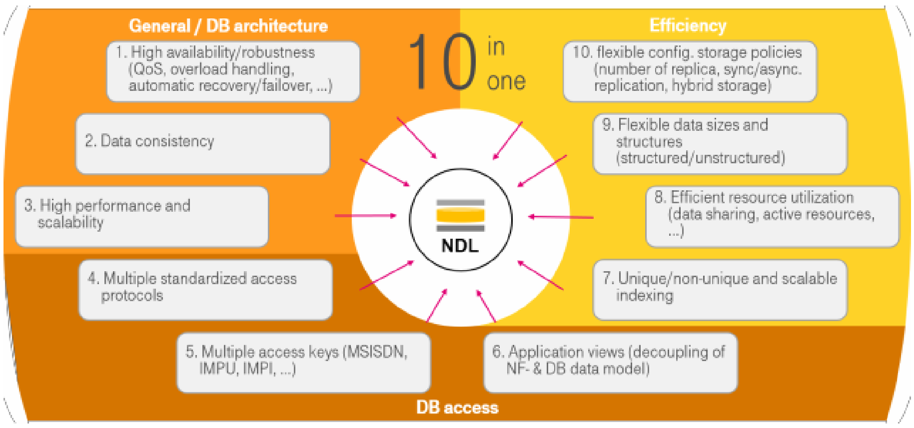

Figure 2: Telco grade database capabilities of NDL.

This white paper focuses on the services to be provided by such an NSP-grade cloud database, called Network Data Layer. In addition, it also describes use cases enabled by the externalization of various types of data.

2 A key feature of a cloud native architecture: A common network data layer

The Network Data Layer (NDL) represents a comprehensive data persistency layer shared by OSS and the network control plane for network and service management (figure 3), as well as a comprehensive data layer for the various 5G Data Storage network Functions (DSFs) for structured and unstructured data (figure 4).

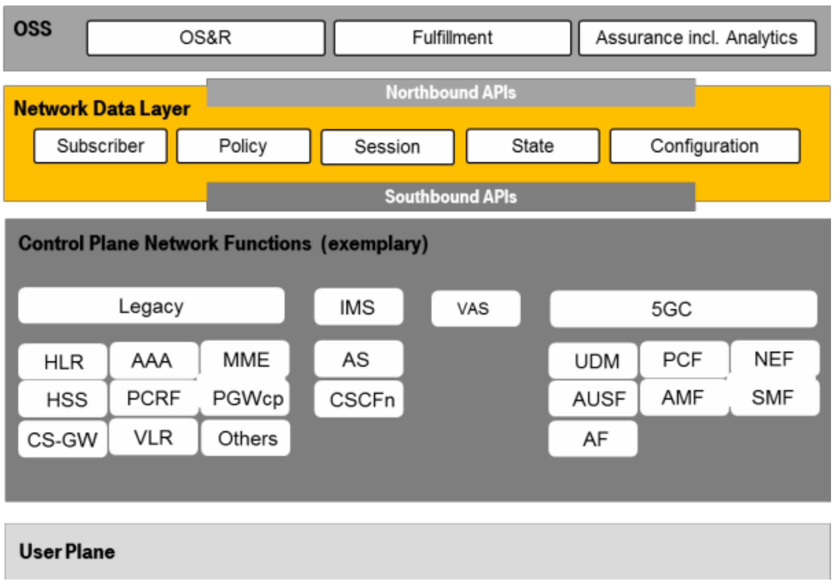

Figure 3: A comprehensive data persistency layer between OSS and the NFs.

Hence, NDL is a strong innovation of today's Subscriber Data Management (SDM, Ud) concept, deployed in many telecommunication networks, addressing network transformation towards cloud and new services (Nudr, Nudsf). NDL corresponds to the Unified Data Layer (UDL) being part of the Service-based architecture in 5G. [2]

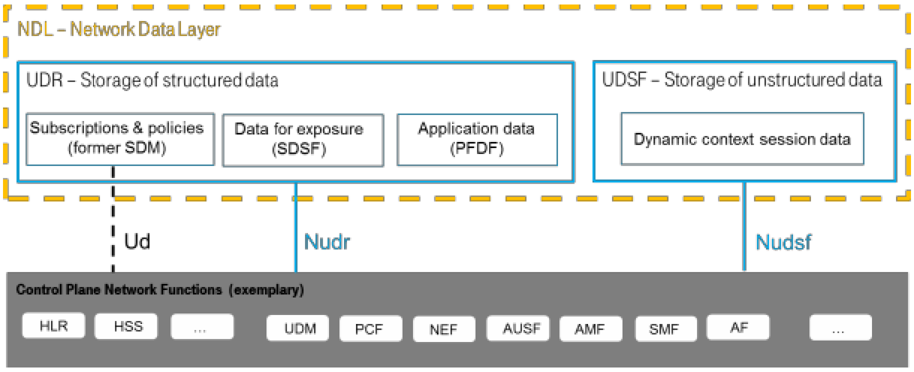

Figure 4: A comprehensive data layer for the various 5G data storage network functions (DSFs)

From a cloud perspective NDL should be considered as yet another VNF using standard IaaS offering (e.g. OpenStack) and with a lifecycle under the control of an open NFV orchestration framework.

NDL represents a single logical network function, which can be distributed across multiple physical data centres. It takes care of the synchronization, replication and the consistency of the data in order for them to be used with any functional component (subject to access control) and to support high availability without any impact to the customer in case of failures.

The different types of data such as semi-persistent subscriber profiles or dynamic context session data could be managed by separate deployed data storage network functions. By using a common framework (NDL), a unique set of data services (figure 5) is implemented only once and can be offered to all clients while still coping with the different characteristics of the various data types and VNF needs. Thus, NDL can form part of a NSP cloud PaaS.

---

[2] quod vide Unified Data Layer (UDL), NGMN „Service-Based Architecture in 5G", V1.0, January 2018

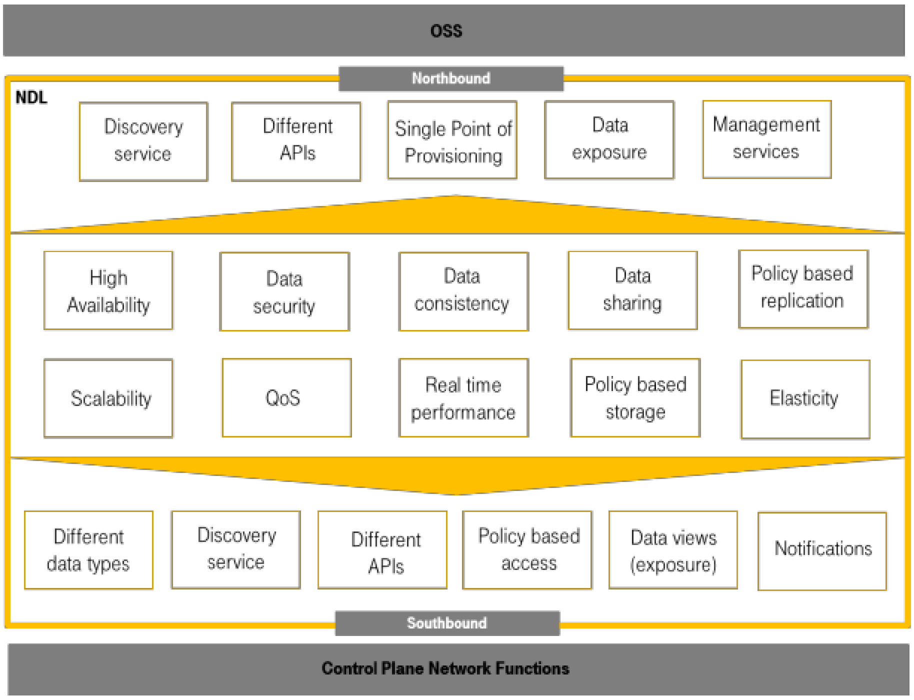

Figure 5: NDL data services.

Mandatory and optional services are offered to store and provide data of various characteristics according to data storage policies (table 1). They can be applied to achieve a best trade-off per data type between high availability, latency and data consistency. Those configurable policies define for instance how many replicas should be maintained, as well as the kind of replication, either local and/or geo-redundant and asynchronous or synchronous. Mixed variants like synchronous local- combined with asynchronous geo-redundant replication are supported as well. In addition, this can be defined with fine granularity where the data can be stored, in-memory or on-disk.

For non-mandatory NDL use cases, VNFs can use alternative data services (siloed DB, DBaaS), if these are not impeding the benefits delivered by the NDL concept.

Mandatory NDL use cases for structured data (UDR)

- Subscription -, policy – and application specific data.
- Global non-subscriber related NF service configuration.
- NF state data (dynamic session context data type 1):
  - Related to user subscription and its UE session-, registration- and connection state.
  - Expected as already standardized (3GPP) or exchanged as part of standardized NF service interfaces with other NFs.
  - Represents a stable state, that can be recovered/re-created by a NF service in failure scenarios w/o any impact on the UE or any other interfacing NF.

Mandatory NDL use cases for unstructured data (UDSF)

- NF state data (dynamic session context data type 2):
  - Related to NF internal state data including internal and NF proprietary data (not part of standards nor exchanged on NF service interfaces).
  - Represents a stable state, that can be recovered/re-created by a NF service in failure scenarios w/o any impact on the UE or any other interfacing NF.

Non-expected NDL use case

- NF state data (dynamic session context data type 3):
  - Related to intermediate transient states of a UE context.
  - Such states exist only for a very short period of time and do not represent a recoverable or stable state, for instance transactional states during NF service dialogs.

Optional NDL use case for structured/unstructured data (UDR/UDSF)

- NDL can be utilized to store other types of NF service data which do not fit into the categories above to avoid additional storage functions and to reduce overall system complexity.

Table 1. Example of NDL mandatory and optional use cases

3 Benefits & use cases enabled by the externalization of various types of data

- **VNF simplification**
  Stateless and dataless VNFs need to implement only the required business processing logic while the complexity of data (e.g. states) persistency and availability is left to data storage capability (NDL). Externalization of data beyond subscriber profiles allows reduction of VNF complexity. Such VNFs do not need to reinvent the data storage with high availability capabilities thus saving additional development capacity that can be utilized on VNF core functionality and features. Stateless VNFs reduce their footprint and become more flexible. Lifecycle management operations, like elasticity or failure recovery is less complex and can be executed faster – effectively utilizing cloud resources.

- **Stateful resiliency of network functions**
  Traditional, fully redundant NF architectures (e.g. 1:n redundancy) and the corresponding data redundancy inside the NFs are not needed anymore. A unified N+K redundancy model together with exclusively all active running components achieve better service availability at less cost. Automated discovery of NDL services combined with externalizing session and state data eases VNFs to recover without service impact and loss of (a large amount of) state information. State/data resiliency level is controlled in a flexible way within the NDL transparently for stateless VNFs.

- **Seamless VNF instance failover**
  Preservation of users' context into a separated data layer helps VNFs to recover from failures without impact on UEs or interfacing network functions. In such situations, the user experience improves significantly. Undesired signalling storms are avoided (due to loss of state information). Operators gain additional benefits as the need to dimension the network to cope with traffic storms is reduced.

- **Data consistency**
  NDL acts as a single point of provisioning for the entire network control plane. Each information is provisioned only once (singular provisioning). In general, NDL ensures that each piece of information will be logically stored only once. As a consequence, all network related data are consolidated and consistent. This leads to a reduction of the data stored (avoiding multiple copies of the same data for every application) that also decreases the required storage capacity costs.

- **Sharing of network data**
  The concept of VNF data sharing facilitates a cross function customer-centric approach. VNFs externalizing their data and states into a separated storage layer enable access to this data by other functions. Even contextual information, such as session data, that is traditionally spread across functions can now be transparently

shared and accessed. Data may be shared between different applications (structured data - UDR) and VNF instances of the same VNF (unstructured data - UDSF).

- **Data model openness**
  As NSPs transform into Digital Service Providers (DSPs), new applications and services need to be integrated continuously. Data adaptation layer utilizing a truly open data model offers unique integration capabilities for current and future service functions and is ready for upcoming service-based interfaces such as HTTP/REST. Data is provided to each application according to their needs with their expected individual view. As a result, each VNF vendor defines its data model (view) and can utilize it in any NDL environment. There is no need to change anything in the VNF. This openness allows all networks (3G, 4G, 5G, broadband, Wi-Fi, and beyond) to co-exist with the same NDL environment and access data as a unified service, ready to support upcoming 5G functions such as UDR and unstructured UDSF functions as defined in 3GPP.

- **Efficiency**
  NDL as cloud database targets to facilitate a higher deployment flexibility. Such flexibility can be achieved by data storage policies. Data storage policy defines the number of replicas (geo-redundant/local), replication modes (async/sync) as well as locations of the replicas. Allowing to distribute and replicate the data for each data item individually increases data efficiency and allows to find the best trade-off between availability, consistency and latency. This flexibility allows the data placement according to the location of the VNF and supporting different cloud deployments (edge clouds, centralized clouds, …).

- **Hybrid storage**
  Utilization of different in-memory and on-disk storage technologies help to avoid traditional limitations. With appropriate combination, highly volatile session states and (semi-)persistent data can be stored with improved efficiency (reduced CAPEX and OPEX) in a single environment. This architecture also offers readiness to support upcoming acceleration technologies, such as persistent memory with unprecedented levels of performance and density in future.

- **Analytics**
  NDL as a consolidated storage concept offers a rich data source for analytics. This provides a valuable, single source of information allowing for more insight to improve services for customers.

4 Architecture cornerstones

Basic principle:

AC.1	Virtual network functions (VNFs) consist of a separated persistency/data tier and data processing functions.
AC.2	Virtual network functions must support 3rd party distributed cloud database (Network Data Layer).

Network Data Layer (NDL):

AC.3	NDL builds a comprehensive data persistency layer shared by OSS and the network control plane for network and service management.
AC.4	NDL builds a comprehensive data layer for the various 5G Data Storage network Functions (DSFs) for structured and unstructured data.
AC.5	NDL offers a unique set of NSP-grade data features, e.g. but not limited to ▪ high availability ▪ data consistency ▪ data integrity ▪ data security ▪ data consolidation / sharing ▪ policy based data replication and storage ▪ policy-based data access ▪ different APIs ▪ notifications ▪ service discovery
AC.6	NDL offers mandatory and optional services to other NFs to store and provide data of various categories and characteristics according to data storage policies.
AC.7	NDL ensures that each piece of information will be logically stored only once (data consolidation) but shared between different VNFs (structured data) and VNF instances of the same VNF (unstructured data) and be presented to the different clients by different virtual data models (also called Views).
AC.8	NDL serves as Single Point of Provisioning for all network services. Each information is provisioned only once.
AC.9	NDL represents a single logical network function, which can be distributed across multiple physical data centres.

AC.10	NDL allows to apply different data storage policies to achieve a best trade-off per data category/type between high availability, latency and data consistency and to ensure proper level of security.

5 Proof points

In the last three years, several vendors made significant investments in NDL technology. Meanwhile NSPs have successfully proven the NDL concept conducting proof-of-concepts and verifying a comprehensive set of KPIs while testing auspicious NDL solutions.

The PoCs covered for instance:

- verification of required functional NDL capabilities (e.g. flexible data storage policies),
- integration of different NDL solutions with various 3rd party clients (e.g. PCRF, IMS core, EPC) considering:
    - externalization of dynamic session context data,
    - different vendor- and VNF implementation approaches on the way to stateless VNFs and
    - verification of seamless VNFI failover based on externalized data in various failure scenarios.

6 Conclusion

The telecommunication industry is facing an enormous challenge with NFV. Cloud-optimized network architectures and cloud native network functions are the key to ensure NFV and to achieve operational efficiency at lowest cost. Hence, the way in which network data is managed plays an important role.

NDL client developers and vendors are aware that they must be prepared to support different DB solutions and deployment models. The database solutions will span on customer request from VNF integrated database (one-box solution) to fully separated external databases (e.g. NDL or others). The data separation into a Network Data Layer is an important measure to support the described use cases.

Related technologies are progressing fast and already fulfil performance expectations widely. Meanwhile current NDL implementations are capable to process multiple thousands of transactions per second (TPS) per VM. Local response times of less than 1ms are achievable. Both, VNF- and NDL-vendors appreciate the NDL concept as it provides significant benefits to all stakeholders.

Learning from experience – a successful introduction of a new concept requires detailed documentation of interfaces and capabilities. The latter combined with providing NDL reference implementations will set the stage for VNF vendors to develop and integrate with NDL.