

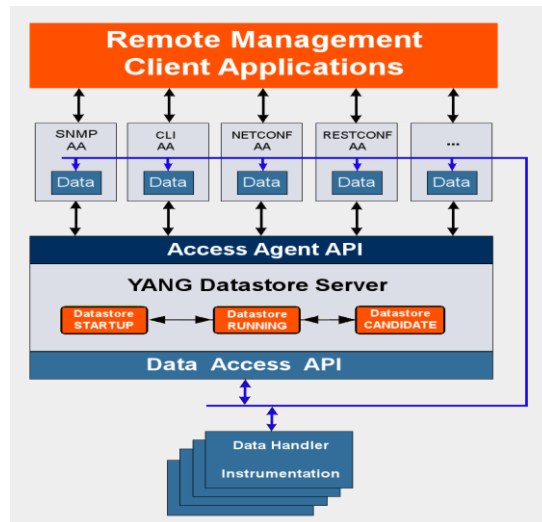
An Overview of NuDesign ndCONF Agent Development Studio Tools

NuDesign's Linux based ndCONF Agent Studio's software tools & SDK technologies enable rapid design of secure ndCONF Agents based on YANG data models, with access to management information via NETCONF, CLI, SNMPv3 and / or web / RESTCONF protocols, enabling progress in automation of Network Service provisioning, their deployment, on-going configurations, monitoring, and self-adaptive, auto-healing and intent driven approaches.

NuDesign ndCONF products target network architectures across all layers, such as Software Defined Networks (SDN), defined by the ONF Foundation¹, O-RAN architecture, defined by O-RAN ALLIANCE², or Network Function Virtualization (NFV) specifications, defined by the ETSI Institute³, that along with the adaptive, self-learning Service Layer, influence the implementation standards for successful deployment and operations of scalable cloud computing, Telco and big enterprise, virtual data center networks.

These management agent software standards provide for rapid control of network's physical devices, then virtual and cloud-native software functions, in order to achieve flexible, application and traffic load optimized connectivity, while assuring secure sharing of networking resources in multi-tenant settings.

NuDesign supports IETF's configuration protocol called NETCONF (rfc6241) and its associated data modeling language called YANG (rfc6020 / rfc7950). YANG is used to define the content: operations, configuration and state data models while NETCONF provides a protocol to remotely manipulate configurations and retrieve operational data from the device. An overview of base capabilities is provided in the informational rfc6244, titled "An Architecture for Network Management Using NETCONF and YANG".



NuDesign's ndCONF management Agent architecture implements extensible YANG Datastore Server, and integrates it with NETCONF & other management protocols, such as RESTCONF, CLI and / or SNMPv3 by providing access to the YANG Datastore objects via these protocol's specific Access Agents.

The aim of NuDesign's ndCONF Agent Studio development tools is to provide YANG / MIB Agent code generation tools, NETCONF / YANG Datastore SDK libraries, YANG & MIB data model builders, and protocol Access Agents for NETCONF, RESTCONF, CLI and / or SNMPv3 software management interfaces.

A developer builds a YANG data model (or uses an existing one), possibly auto-converting previous generation equipment's existing SNMP MIBs into rfc6643 compliant YANG modules, optionally modifying them to better express the native features of the device being managed and to provide a more "CLI centric" data model.

¹ Open Networking Foundation (<http://www.opennetworking.org>)

² O-RAN ALLIANCE (<https://www.o-ran.org>)

³ European Telecommunications Standards Institute (<http://www.etsi.org>)

Now, using NuDesign's ndCONF Builder, a C++ code generator of YANG Datastore Server object providers, a Loadable Data Handler Server extension project is generated, with nodes derived from the YANG module definitions. The YANG Datastore gets populated via configuration initialization, then by on-going manipulations.

The required Loadable Data Handler module handlers are created, added and registered with the DataTemplate. The ndCONF Builder also provides for customer's callback functions to enable incorporation of user code into the automatically generated code. The ndCONF Builder dramatically simplifies and speeds up the development process of a new product.

Access to object instrumentation is performed via one or more protocol specific Access Agents. The addition of an Access Agent to the core YANG Datastore Server requires the inclusion of support code and configuration files, auto-generated for desired access. The following tools and components are provided with NuDesign's **ndCONF Agent Development Studio**:

- **ndCONF Builder** – a Linux / PYANG hosted plug-in, C++ source code and project generator of **YANG Datastore Server** Loadable Data Handler extensions for YANG rfc6020 / rfc7950 modules.
- **ndCONF SDK** – a complete management agent development platform containing: extensible **YANG Datastore Server**, **NETCONF / YANG Datastore SDK** libs with APIs to YANG Datastore object providers, APIs to protocol **Access Agents**, samples and support tools. It contains basic **CLI Access** to operational & configuration aspects of the system. Multiple, dynamically Loadable Data Handler extensions are supported.
- **NETCONF Access Agent** – this Access Agent, along with YANG Datastore Server implement the IETF's Network Configuration protocol described in rfc6241 (NETCONF Protocol), rfc6242 (NETCONF over SSH), rfc7589 (NETCONF over TLS), rfc6022 (NETCONF Monitoring), rfc6021 (YANG and INET Data Types), rfc5277 (NETCONF Event Notifications), rfc6470 (NETCONF Base Notifications), rfc6536 (NETCONF Access Control) & other modules.
- **SNMPv3 Access Agent** – this Access Agent provides a full implementation of the IETF's SNMPv3 standard, including rfc7407 (YANG Data Model for SNMP Configuration). It provides SNMP access capability to the YANG Datastore via a "MIB view" enabled for those YANG modules that also have corresponding MIB documents defined. Support for existing NuDesign's or AgentX Subagents is provided.
- **CLI Access Agent** – this Access Agent implements a sophisticated, multi-user CLI interface constructed using provided tools and SDK libraries. It supports extensible Cisco and Juniper like emulation with operational and configuration modes, allowing for modifications of existing and additions of new commands.
- **RESTCONF Access Agent** – this Access Agent enables RESTCONF web access to the YANG Server's XML Datastore, via the system's web server and fastCGI interface. Developers add dynamic content to their custom applications using well known web application technologies.

An automatically generated and developer instrumented YANG Datastore Server can be deployed with any combination of protocol specific Access Agents supplied by NuDesign, providing an OEM device with a well integrated ndCONF Agent solution exposing secure & synchronized NETCONF, CLI, SNMPv3 and / or RESTCONF / Web interfaces to existing and future orchestration, provisioning, management and automation processes.

About NuDesign Technologies

NuDesign Technologies, Inc., based in Toronto, ON, Canada, specializes in providing NETCONF, RESTCONF, CLI & SNMPv3 Agent & Manager development applications, tools, libraries and consulting services to developers and networking OEMs worldwide. The benefits of deploying NuDesign's management software technologies are reliable, low risk, well integrated and quick-to-market solutions, supporting remote management operations over secure networks in carrier, campus, enterprise and IoT settings.

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