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Terminology and Requirements for Enhanced Handling of Operational State  
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Abstract

This document primarily regards the difference between the intended configuration and the applied configuration of a device and how intended and applied configuration relate to the operational state of a device. This document defines requirements for the applied configuration's data model and its values, as well as for enabling a client to know when a configuration has been fully applied or not, how to access operational state, and how to relate intended configuration nodes to applied configuration and derived state nodes.

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[1.](#) Introduction

This document primarily regards the difference between the intended configuration and the applied configuration of a device and how intended and applied configuration relate to the operational state of a device. This document defines requirements for the applied configuration's data model and its values, as well as for enabling a client to know when a configuration has been fully applied or not, how to access operational state, and how to relate intended configuration nodes to applied configuration and derived state nodes.

[2.](#) Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

The term "client" is used throughout this document to refer to what is many times known as the "application" or "network management system". This definition is intended to be consistent with the term "client" defined in [\[RFC6241\]](#), [Section 1.1](#), but independent of any association to a particular protocol.

The term "server" is used throughout this document to refer to what is many times known as the "device", "system", or "network element".

This definition is intended to be consistent with the term "server" defined in [\[RFC6241\], Section 1.1](#), but independent of any association to a particular protocol.

This document defines the following terms:

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**Applied Configuration:** This data represents the configuration state that the server is actually in. That is, the configuration state which is currently being used by server components (e.g., control plane daemons, operating system kernels, line cards). With respect to NETCONF architecture, the applied configuration resides in the "system software component" box listed on page 15 of [\[RFC6244\]](#)

NOTE: The server's ability to report applied configuration accurately may be limited in some cases, such as when the configuration goes through an intermediate layer without an ability to inspect the lower layer.

**Asynchronous Configuration Operation:** A configuration request to update the running configuration of a server that is applied asynchronously with respect to the client request. The server MUST update its intended configuration before replying to the client indicating whether the request will be processed. This reply to the client only indicates whether there are any errors in the original request. The server's applied configuration state is updated after the configuration change has been fully effected to all impacted components in the server.

**Derived State:** This data represents information which is generated as part of the server's own interactions. For example, derived state may consist of the results of protocol interactions (the negotiated duplex state of an Ethernet link), statistics (such as message queue depth), or counters (such as packet input or output bytes).

**Intended Configuration:** This data represents the configuration state that the network operator intends the server to be in, and that has been accepted by the server as valid configuration. With respect to NETCONF architecture, the intended configuration is captured by the "config database" box listed on page 15 of [\[RFC6244\]](#)

Operational State: Operational State is the current state of the system as known to the various components of the system (e.g., control plane daemons, operating system kernels, line cards). The operational state includes both applied configuration and derived state.

Synchronous Configuration Operation: A configuration request to update the running configuration of a server that is applied synchronously with respect to the client request (i.e. a blocking call). The server MUST fully attempt to apply the configuration change to all impacted components in the server, updating both

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the server's intended and applied configuration, before replying to the client. The reply to the client indicates whether there are any errors in the request or errors from applying the configuration change.

### 3. Requirements

1. Ability to interact with both intended and applied configuration
  - A. The ability to ask the operational components of a server (e.g., line cards) for the configuration that they are currently using. This is the applied configuration.
  - B. Applied configuration is read-only
  - C. The data model for the applied configuration is the same as the data model for the intended configuration (same leaves)
  - D. When a configuration change for any intended configuration node has been successfully applied to the server (e.g. not failed, nor deferred due to absent hardware) then the existence and value of the corresponding applied configuration node must match the intended configuration node.
2. Support for both synchronous and asynchronous configuration operations
  - A. A server MUST support only synchronous configuration

operations, or only asynchronous configuration operations, or both synchronous and asynchronous configuration operations on a client-specified per-operation basis.

- B. Servers that support asynchronous configuration operations MUST provide a mechanism to notify the client when a request has completed processing. The notification MUST indicate whether the intended config is now fully applied or if there were any errors from applying the configuration change.
- C. Servers that support asynchronous configuration operations SHOULD also provide a verify operation that a client can request from the server to return information regarding the difference between the intended and applied configurations.
- D. The configuration protocol MUST specify how configuration errors are handled. Errors SHOULD be handled by semantics similar to NETCONF's error-options for the <edit-config> operation (stop-on-error, continue-on-error, rollback-on-

error), as described in [Section 7.2 in \[RFC6241\]](#), but extended to incorporate both the intended and applied configurations. Support for "rollback on error" semantics SHOULD be provided.

- 3. Separation of the applied configuration and derived state aspects of operational state; ability to retrieve them independently and together
  - A. Be able to retrieve only the applied configuration aspects of operational state
  - B. Be able to retrieve only the derived state aspects of operational state
  - C. Be able to retrieve both the applied configuration and derived state aspects of operational state together
- 4. Ability to relate configuration with its corresponding operational state
  - A. Ability to relate intended config nodes to corresponding

applied config nodes

- B. Ability to relate intended config nodes to associated derived state nodes
  - C. The relationships need to be programmatically consumable
5. Backwards compatibility
- A. It MUST be possible to upgrade a server to one that supports the solution without breaking existing/legacy clients.
  - B. It MUST be possible for a client that has been coded to support the solution to interoperate appropriately with existing/legacy servers.

#### 4. Security Considerations

It is understood that the intended and applied configurations will differ while synchronization is in progress. During the synchronization process, the server will be in an inconsistent state from the client's perspective. Implementations need to take care to ensure that this process minimizes gaps in the application of security policy (e.g., replacing a firewall policy in a single step). Implementations additionally need to ensure that any gaps in security

policies are not dependent on external input that an attacker might be able to control or prevent access to.

#### 5. IANA Considerations

None

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## 7. References

### 7.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.

### 7.2. Informative References

- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", [RFC 6241](#), DOI 10.17487/RFC6241, June 2011, <<http://www.rfc-editor.org/info/rfc6241>>.
- [RFC6244] Shafer, P., "An Architecture for Network Management Using NETCONF and YANG", [RFC 6244](#), DOI 10.17487/RFC6244, June 2011, <<http://www.rfc-editor.org/info/rfc6244>>.

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