**3GPP TSG-SA5 Meeting #162 *S5-253333***

Gothenburg, Sweden, 25 – 29 August 2025

**Source: Nokia**

**Title: Pseudo-CR on Restructure clauses**

**Document for: Approval**

**Agenda item: 6.19.4.1**

**Spec: 3GPP TS28.567**

**Version: 0.2.0**

**Work Item: Closed Control Loop Management**

**Comments**

The use case sin the TS were contributed at different times and do not have a clear coherent structure. Tis pCR is to restructure them to give some coherence. In particular

* Use cases on triggered CCL are added together with dynamic control
* The use case on CCL creation based on historical data is added under with dynamic control capabilities
* The use case on Coordinating CCLs with other management functions is combined with the CCL Conflict management capabilities

**Proposed Changes**

\* \* \* First Change \* \* \* \*

# 5 Management capabilities

## 5.1 Dynamic control and composition of CCLs - DynCCL

### 5.1.1 Description

CCLs may be dynamically realized. There are two aspects to dynamically realization of CCLs - dynamic instantiation of a CCL from an existing template and dynamically composing the CCL from discrete components based e.g. on the provided goals.

### 5.1.2 Use cases

#### 5.1.2.1 General CCL Control – DynCCL\_01

A CCL contains a set of logic functionalities or steps, each providing a specific functionality and where the steps work together to achieve the stated desired outcomes over a given network scope. The MnS consumer should be able to configure and receive information about the desired outcomes of the CCL.

Generally, the four CCL steps of Monitoring, Analysis, Decision and Execution are expected with the expectation that each step is accomplished by a single management function or service. However, one management function or service may also accomplish the functionality of more than 1 step. The MnS consumer should be able to receive information about the management functions or services that form the CCL.

A CCL may have four scopes including a desired outcomes scope, measurement scope, a control scope and an impact scope. The scopes for the different CCLs can be managed by the MnS consumer. The MnS consumer should also be able to receive reports about these different aspects of the CCL, e.g., about the status of the CCLs execution as well as to configure the reporting.

#### 5.1.2.2 Composing a CCL from discrete components – DynCCL\_02

A CCL may be composed from steps provided by different management functions or management services. i.e. the CCLs is assembled on demand by MnS consumers, using capabilities offered by the Management system, e.g. from independent management functions. The CCLs components, as well as the communication and interoperation between components, are based the different 3GPP management services. Accordingly, the MnS consumer should be able to identify and indicate the MnFs or MnS producers that should be used to compose a CCL. Moreover, the MnS consumer may indicate towards the MnS producer the request to compose the CL of a particular type (e.g. for optimizing energy efficiency) without requiring to state the specific components that should be used.

Two approaches are possible:

- Composition from management Functions: Different management functions may be used to realize the different steps of a closed loop, for example, an MDA function may realize the analytics step of the CCL while another management function may realize the decision step of the CCL.



Figure 5.1.2.2-1: Management functions as steps of a closed control loop

- Composition from management services: Different management services may be used to realize the different steps of a closed loop, i.e. the management service provides the output expected from a specific step.

EXAMPLE: A capability of the MDA MnS realizes an analytics step of the CCL while another capability may realize a specific data collection step of the CCL.

 b)

Figure 5.1.2.2-2: Management services used as implementations of CCL steps:  
a) MDA MnS and PM job the respective implementations of the analysis and data collection steps; and b) MDA MnS as the implementation of the decision step

The MnS consumer should be enabled to control the composition of such a CCL. The MnS consumer could request for and be notified about the composition of a CCL from a set of specific components (i.e. specific management functions or management services). The request could indicate components with specific given capabilities (such as analytics services with specific analytics types) which should be combined to achieve the closed loop. Moreover, the request could be for composition of a CCL required to achieve a specific set of desired outcomes or goals.

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#### 5.1.2.4 CCL creation based on Historical CCL data capability – DynCCL -04

This use case describes the need of maintaining information about the CCLs that existed in the past. Those CCLs are called Historical CCLs.

In an automation environment, before a consumer request to create a CCL it would like to know the data related with Historical CCLs that were available with the producer. This information will enable consumer to request for an optimal CCL. The information about historical CCL may include, scope of the CCL, configured goals/targets, controlled entity, etc.

Further, Historical CCL information serves as a valuable data source for predictive analytics within the CCL system executed as Analytics step. It enables the system to move from a reactive mode, where it responds to current issues, to a proactive mode, where it anticipates and prevents problems based on historical trends and patterns. This proactive approach enhances network reliability, minimizes downtime, and improves the overall efficiency of network operations.

The Historical CCL information may be used by the management system to setup or initialize a CCL. The Historical CCL information provides the profiles of a CCL for CCL at different hierarchies. For example, CCLs that do not do coordination which are at a lower hierarchy L and CCLs responsible for coordination (as coordination entities) which are at a higher hierarchy H. For a new CCL at a lower hierarchy, the management system obtains the profiles of the several CCLs at different hierarchies and correlates the information of the new CCL (e.g. its goal information) against the profiles of the CCLs at the different hierarchies. Based on this, the management system computes the complete profile of the new CCL (including e.g. its measurement and control scope) which is then configured onto the new CCL.

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### 5.1.3 Requirements

Table 5.1.3-1

|  |  |  |
| --- | --- | --- |
| Requirement label | Description | Related use case(s)/ Motivation |
| REQ-DynCCL\_01-01 | The CCL MnS Producer should support a capability to provide information to the MnS consumer about the management functions and services that make up the CCL and where applicable the functionality accomplished by the components. | UC-DynCCL\_01  Clause 5.1.2.1 |
| REQ-DynCCL\_01-02 | The CCL MnS Producer should support a capability enabling the MnS consumer to configure and receive information on status of execution of the CCL. | UC-DynCCL\_01  Clause 5.1.2.1 |
| REQ-DynCCL\_01-03 | The CCL MnS Producer should support a capability enabling the MnS consumer to configure and receive information on the scopes of the CCL | UC-DynCCL\_01  Clause 5.1.2.1 |
| REQ-DynCCL\_01-04 | The CCL MnS Producer should support a capability to report to the MnS consumer about the CCL | UC-DynCCL\_01  Clause 5.1.2.1 |
| REQ-DynCCL\_02-01 | The CCL MnS Producer should support a capability enabling the MnS consumer to request for a CCL (instance) to be composed from a set of management function types or instances or management services | UC-DynCCL\_02  Clause 5.1.2.2 |
| REQ-DynCCL\_02-01 | The MnS producer for CCL management should support a capability enabling the MnS consumer to request that a CCL of a specific type or fulfilling a stated goal should be composed from a set of management function types or instances or services | UC-DynCCL\_02  Clause 5.1.2.2 |
| REQ-DynCCL\_02-01 | The MnS producer for CCL management should support a capability enabling the MnS consumer to provide conditions under which a CCL can be dynamically composed or instantiated triggered to execute | UC-DynCCL\_02  Clause 5.1.2.2 |
| REQ-DynCCL\_02-01 | The MnS producer for CCL management should support a capability enabling the MnS consumer to be notified when a CCL is dynamically composed or instantiated or triggered to execute | UC-DynCCL\_02  Clause 5.1.2.2 |
| REQ- DynCCL\_03-01 | The 3GPP management system should enable authorized MnS consumer to request for information (e.g. CCL identification, configured goals/targets and the related status, scope of the CCL, conflict information) related with Historical CCL. | UC- DynCCL\_03  Clause 5.1.2.3 |
| REQ- DynCCL\_03-02 | The 3GPP management system shall have the capability to configure the profile of a CCL based on the historical CCL information that describes the profile of other CCLs at different hierarchies. | UC- DynCCL\_03  Clause 5.1.2.3 |
| REQ- DynCCL\_04-01 | The 3GPP management system should enable authorized consumers to define conditions related to performance, fault and configuration data that can be monitored and used to trigger CCL instantiation. | UC– DynCCL\_04  Clause 5.1.2.4 |
| REQ- DynCCL\_04-02 | The 3GPP management system should enable authorized consumers to define conditions related to performance, fault and configuration data that can be monitored and used to trigger CCL update. | UC– DynCCL\_04  Clause 5.1.2.4 |
| REQ- DynCCL\_05-03 | The 3GPP management system should enable authorized consumers to define conditions related to performance, fault and configuration data that can be monitored and used to trigger CCL deletion. | UC– DynCCL\_05  Clause 5.1.2.5 |
| REQ- DynCCL\_05-01 | The 3GPP management system should enable authorized consumers to define conditions related to performance, fault and configuration data under which a CCL may execute its actions. | UC– DynCCL\_05  Clause 5.1.2.5 |



## 5.2 CCL Performance Monitoring - CCLPERF

### 5.2.1 Description

TBD

### 5.2.2 Use Cases

#### 5.2.2.1 Performance Evaluation of a Closed Control Loop – CCLPERF\_01

The advanced monitoring functionalities of a CCL can provide real-time insights into the performance and outcomes of a CCL. The monitoring activity for a Closed Control Loop may result in further actions that happen in the operation phase, e.g., evaluate and update, in order to change the closed control loop settings and improve its performance. So, there is a need to evaluate the performance of a Closed Control Loop itself. Such metrics are important to understand and change a CCL's behaviour and to improve its performance to pursue the assigned goal(s).

For example, certain performance aspects of a CCL can be very crucial to know in order to evaluate and decide upon a CCL's performance, such as the number of breached goals, time taken to meet a breached goal, number of conflicts occurred by a CCL etc. With the knowledge of such performance aspects of an existing CCL, a MnS consumer can more effectively update or create a new CCL.

An operator can also compare different CCLs based on these performances and choose the best one for its network deployment.

#### 5.2.2.2 MnS Consumer’s feedback on CCL actions – CCLPERF\_02

A CCL should derive its actions without the involvement of any other entity (such as the managed network object) but the actions can have different levels of satisfaction for the different MnS consumers. The MnS consumers should be able to provide feedback to the CCL indicating how satisfied the MnS consumer is with the quality of the CCL actions, which should enable the CCL to fine‑tune and optimize its decisions.

EXAMPLE: The MnS consumer feedback may grade the usefulness of the executed action on a fixed scale say from 0 (indicating a terrible and never to be re-used action) to 10 (indicating a very good action for the interests of the MnS consumer). Other criteria may be added, e.g., to address the case that two consumer experience the same outcomes but may have different grade for feedback,

To be able to gauge the satisfaction, the MnS consumer should be able to receive information about the provisioning operations executed by the CCL. This information includes operation performed, MOIs updated, etc. The CCL does not break its execution when it provides information to the MnS consumer or to wait for feedback from the MnS consumer. The feedback from an MnS consumer does not break the loop.

It may be needed to determine what impact the CCLs’ action(s) had on a given scope that is the responsibility of other CCLs. Based on the CCL actions and the resulting impact on PMs, it may be determined that new actions are needed to undo the degradation and to avoid it in future.

Based on some local policies or due to degradations observed, the consumer may prefer that a particular NF is not updated as part of the Execution step of CCL. The consumer should be enabled to request the CCL to revoke the changes made to a NF. Consumer may also update the CCL to ensure that a particular NF is never updated in future.

#### 5.2.2.3 Assessment and resolution of CCL Impact on unknown impact-scope - CCLPERF\_03

For some CCLs, the impact-scope affected by the actions of a CCL A may not be known a priori. For example, when a CCL A adjusts transmit power (e.g. to minimize interference), the neighbour cells and related CCLs acting on those cells that would be affected by any transmit power decrease or increase cannot be explicitly enumerated. Any negative effects cannot be easily anticipated, and most may not be easy to resolve by if‑then-else rules. Instead, the affected CCLs should report their observed negative or positive impacts to CCL A to determine how to resolve the impact or avoid them in future.

'Related CCLs need to be notified that CCL A has executed an action and the impact-time of the action, i.e. the maximum time within which the action is expected to have impact and at which an observed impacts should be reported. For example, the impact of load balancing is visible in a few seconds while the impact of a handover decision can take several minutes. After the notified impact time, the impacted CCLs need to report the impact that CCL A had to their performance metrics . The impact may be reported an index say in the range [0,10] where 0 implies an unacceptable action and 10 implies a good action. CCL A can then derive an appropriate remediation, e.g. by reconfiguring the candidate actions of the acting CCL (i.e. CCL A) or by undoing the action.

### 5.2.3 Requirements

Table 5.3.3-1

| Requirement label | Description | Related use case(s)/ Motivation |
| --- | --- | --- |
| REQ-CCLPERF\_01 -01 | The 3GPP management system should be able to obtain a CCL's performance with respect to the total number of occurrences of a goal breach. | UC-CCLPERF\_01  Clause 5.3.2.1 |
| REQ-CCLPERF\_01-02 | The 3GPP management system should be able to obtain a CCL's performance with respect to the time taken by CCL to meet a breached goal. | UC-CCLPERF\_01  Clause 5.3.2.1 |
| REQ-CCLPERF\_01-03 | The 3GPP management system should be able to obtain a CCL's performance with respect to the total number of conflicts occurred by a CCL | UC-CCLPERF\_01  Clause 5.3.2.1 |
| REQ-CCLPERF\_02-01 | The 3GPP management system should enable MnS consumer to provide its feedback on the action(s) taken by CCL. | UC-CCLPERF\_01  Clause 5.3.2.2 |
| REQ- CCLPERF\_02-02 | The 3GPP management system should enable MnS consumer to request for revocation of the action(s) taken by the CCL. | UC-CCLPERF\_01  Clause 5.3.2.2 |
| REQ-CCLPERF\_02-03 | The 3GPP management system should have a capability enabling the MnS consumer to receive information (e.g. operation performed, MOIs updated) about the action(s) taken by a CCL A. | UC-CCLPERF\_01  Clause 5.3.2.1  UC-CCLPERF\_02  Clause 5.3.2.2 |
| REQ-CCLPERF\_03-01 | The 3GPP management system should support a capability enabling an MnS consumer to receive a report containing an executed action and the impact that the action had to a particular impact-scope. | UC-CCLPERF\_02  Clause 5.3.2.2  UC-CCLPERF\_03 Clause 5.3.2.3 |
| REQ-CCLPERF\_03-02 | The 3GPP management system should support a capability enabling an MnS consumer to propose to a CCL a remediation against the noted impact of a CCLs’ actions, e.g. the reconfiguration of the candidate actions of the CCL. | UC-CCLPERF\_03 Clause 5.3.2.3 |

## 5.3 Closed Control Loops usage scenarios - CCLUSE

### 5.3.1 Description

Closed control loops can be used for different purposes or scenarios Two example scenarios are fault management and network performance problem recovery.

### 5.3.2 Use Cases

#### 5.3.2.1 Closed Control Loops for fault management – CCLUSE\_01

This use case describes a scenario in which an MnS consumer may request a CCL for fault management. The consumer may request to identify the root cause of the fault and take actions to mitigate and/or resolve the root cause for a given list of alarms. Furthermore, the request may include policies and actions specified by an MnS consumer in order to mitigate and/or resolve the root causes for the given alarms.

Based on the request, a CCL may take action to further enhance the correlation of alarms, for example, correlation of alarms with change in PM/KPIs and/or fault supervision events to find solutions to mitigate and/or resolve the identified root causes. In addition, a fault management CCL may clear the alarms that otherwise have to be manually cleared by the MnS consumer, which are defined as ADMC Alarms in TS 28.111.

The MnS producer reports the result of fault management. The report may include information regarding the status of each alarm, including any identified root cause and correlation information, which may indicate the successful mitigation and/or resolving of root causes for any given alarm.

#### 5.3.2.2 Closed Control Loops for network performance problem recovery CCLUSE\_02

Based on the concept in 3GPP TS 28.104 [3], MDA reports may contain root cause analysis of ongoing issues, predictions of potential issues and corresponding relevant causes and recommended actions for preventions, and/or prediction of network and/or service demands. For example:

- MDA for Coverage problem analysis can provide the following information in the MDA report:

- coverageProblemId;

- coverageProblemType;

- coverageProblemAreas; and

- recommendedActions.

MnS consumer may decide to resolve the observed performance problems based on the analytics reports (e.g. provided by MDA) and other management data (e.g. historical decisions made previously) if necessary. It can be possible that one MnF is responsible for network performance problem observation and recovery, while another MnF is responsible for decision on whether the network performance problem needs to be resolved. In this scenario, The MnF for decision can decide whether needs the another MnF to recovery the observed network performance problems (e.g. coverage problem) based on MDA report (e.g. root cause information, recommended solutions) and other information (e.g. user experience information, information from other domains). If decides to recover the observed network performance problems, The MnF for decision needs to request another MnF to recover the specified network performance problems observed from the MDA report. MnS consumer may specifies the network scope and time window for network performance problem recovery, which means the MnS producer needs to recover the problem at the specified time window for the network scope. During problem recovery phase, as process for network performance problem recovery is complex and time-consuming, the MnS consumer needs to obtain the progress of the recovery process. When the last step of the network performance problem process is completed, MnS producer needs to send the result of this network performance problem recovery process to the MnS consumers.

If a closed control loop instance can be used to resolve network performance problem, the MnS consumer may need to know the result of resolving the network performance problem by the closed control loop instance, including the network performance problems which are resolved by the closed control loop as well as network performance problem resolution statistics (e.g. the number of network problem resolved by the closed control loop in the specified period).

### 5.3.3 Requirements

Table 5.4.3-1

|  |  |  |
| --- | --- | --- |
| Requirement label | Description | Related use case(s)/ Motivation |
| REQ-CCLUSE\_01-01 | The 3GPP management system shall have the capability to allow MnS consumer to request a closed control loop for fault management | UC-CCLUSE\_01 |
| REQ-CCLUSE\_01-02 | The 3GPP management system shall have the capability to allow MnS consumer to get a report from the closed control loop regarding the status of fault management | UC-CCLUSE\_01 |
| REQ-CCLUSE\_02-01 | The 3GPP management system should have the capability to allow the MnS consumer to request a CCL for resolving the network performance problems. | UC-CCLUSE\_02  Closed Control Loops for network performance problem recovery |
| REQ-CCLUSE\_02-02 | The 3GPP management system should have the capability to allow the MnS consumer to obtain the result of network performance problem resolved by the closed control loop. | UC-CCLUSE\_02  Closed Control Loops for network performance problem recovery |
| REQ-CCLUSE\_02-03 | The 3GPP management system should have the capability to allow the MnS consumer to obtain the progress information of network performance problem recovery. | UC-CCLUSE\_02  Closed Control Loops for network performance problem recovery |
| REQ-CCLUSE\_02-04 | The 3GPP management system should have the capability to allow the MnS consumer to configure a CCL with the network scope and time window to be monitored for i resolving the network performance problems. | UC-CCLUSE\_02  Closed Control Loops for network performance problem recovery |

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## 5.4 CCL Conflict management and coordination - CONF

### 5.4.1 Description

#### 5.4.1.1 Overview

A CCL may experience direct conflicts on its goals, targets, scopes, trigger time and execution time. The management system needs to support capabilities to avoid, detect and resolve the conflicts.

The possible conflict scenarios are defined as follows:

- **CCL Scope conflicts:** These are conflicts among the scopes of the CCLs, specifically the scenarios where a given scope is considered differently by distinct CCL instances. An example is where the measurement scope of one CCL is the control scope of another CCL. Where applicable, it is desirable that the scopes are allocated such that that one CCL instance does not read a scope that is concurrently being controlled or adjusted by another CCL. These also include conflict among the desired outcomes of the individual CCLs sharing a given scope.

- **CCL actions conflicts:** These are conflicts among the actions of the CCLs, specifically the scenarios where two CCL instances attempt to differently control the same parameters of the same managed objects. Where applicable, it is desirable that the actions are decided and allowed such that that two CCL instances will not control or adjust the same set of parameters on the same set of managed objects.

There are 2 subtypes of CCL actions conflicts – concurrent and non-concurrent actions conflicts.

- **CCL concurrent actions conflicts:** These are conflicts where the actions are executed within a time period less than the impact time of the action, i.e., the action of the second CCL instance is executed before the impact of the first CCL instance is registered. In the simplest scenario, the two CCL instances try to execute the contradictory actions at exactly the same time. Concurrent actions conflicts are also called “action-execution-time conflicts”

- **CCL non-concurrent actions conflicts:** These are conflicts where the actions are executed within a time period longer than the impact time of the action, i.e., the action of the second CCL instance is executed after the impact of the first CCL instance is registered. The second CCL instance in effect tries to undo the impact of the CCL instance.

- **CCL metric-value conflicts:** These are conflicts for the desired value of one or more performance metrics by two CCL instances that do not have conflicts for desired outcomes on stated scopes or actions. The two CCL instances which have different desired outcome and two distinct control and measurement scopes but the actions of one CCL instance have impact on the measurement scope of the other CCL instance, i.e. one CCL’s actions will indirectly affect the network performance metrics that the other CCL is responsible for. For example, a conflict could occur among the metrics if a CCL that optimizes energy consumption affects handover performance metrics which are supposed to be optimized by another CCL.

There are 2 subtypes of CCL metric-value conflicts – concurrent and non-concurrent metric-value conflicts.

- **CCL concurrent metric-value conflicts**: These are metric-values conflicts between CCLs with close trigger times, i.e., where the CCL instances are triggered to act concurrently or to execute actions within the same time.

- **CCL non-concurrent metric-value conflicts**: These are conflicts where the CCL instances are triggered to act in different time periods, e.g. where one CCL instance is active while the other is only monitoring its measurement scope.

#### 5.4.1.2 Example conflicts

Examples characterizing the differences among the conflicts are summarized by Table 5.4.1-1.

Table 5.4.1-1: Types of potential conflicts among CCL instances for desired outcome g1, g2 and g3

| Conflict Type | Description | CCL-A | CCL-B | Comments |
| --- | --- | --- | --- | --- |
| Scope conflict | For CCLs CCL-A and CCL-B, CCL-A and CCL-B have different desired outcomes and actions but their scopes are overlapping - e.g. CCL-A's control scope (i.e. the controlled entities in the network) is part of CCL-B's measurement scope (i.e. the measured entities in the network). | Measurement scope:  - cells g1  Control Scope:  - g1  Desired outcome:  - EC/bit is < 1WA  Actions:  - Entity: gNB-g1  - Change: switch off g1 | Measurement scope: cells g1, g2, g3, g4  Control Scope:  - g2  Desired outcomes:  - Load < 80 %  Actions:  - Entity: gNB-g2  - Change: change CIO | By switching off g2, CCL-A affects the scope which CCL-B reads for its load distribution measurements |
| Action Conflict | **Concurrent direct actions conflicts:**  For CCLs CCL-A and CCL-B, when both CCL-A and CCL-B are trying to configure the same characteristics of same entity (gNB-g1) in contradiction, the actions executed within a short time period e.g. less than the impact period of their actions | expected outcomes:  - Throughput > 10 Gbps  Actions:  - Entity: gNB-g1  - Change: scale-out  - Time: 04:00 | expected outcomes:  - EC is < 10KVA  Actions:  - Entity: gNB-g1  - Change: scale-in  - Time: 04:00 | Conflict due to the time of executing the configuration actions on the same scope at the execution step |
| **Non-concurrent direct actions conflicts:**  For CCLs CCL-A and CCL-B, when both CCL-A and CCL-B is trying to configure the same characteristics of same entity (gNB‑g1) in contradiction, the actions far apart from each other; e.g. in a time period longer than the impact period of their actions | Example 1 | | Conflict due to configuration actions at execution step because both CCL want contradicting values for a particular characteristic of gNB-g1.  Effect: the value may ping-pong continuously. |
| expected outcomes:  - Throughput > 10 Gbps  Actions:  - Entity: gNB-g1  - Change: scale-out virtual resource | expected outcomes:  - EC is < 10 KVA  Actions:  - Entity: gNB‑g1  - Change: scale-in virtual resource |
| Example 2 | |
| expected outcome:  - HO failure is < 2 %  Actions:  - Entity: gNB-g1  - Change: set CIO to a small **positive** value{to guarantee HOs with low chances of HO failure} | expected outcome:  - Load < 80 %  Actions:  - Entity: gNB-g1  - Change: set CIO to a small negative value [to advance HOs and move load to other cells] |
| Metric-value conflict | **CCL concurrent metric-value** **conflicts:** For CCLs CCL-A and CCL-B, when CCL-A [optimize handover] and CCL-B [minimize interference] have different Desired outcomes but are executed within a short time intervals between each other and the actions of CCL-A affect the Desired outcomes of CCL-B. | expected outcome:  - HO failure is < 2 %  Actions:  - Entity: gNB-g1  - Change: reduce CIO {to reduce chances of HO failure} | expected outcome:  - SINR > 10 dB  Actions:  - Entity: gNB‑g1  - Change: lower antenna tilt | By reducing antenna tilt to minimize interference CCL-B affect the HO Desired outcome being optimized by CCL-A |
| **CCL concurrent metric-value** **conflicts:** For CCLs CCL-A and CCL-B, when CCL-A [optimize handover] and CCL-B [minimize interference] have different Desired outcomes but are executed far apart from each other but the actions of CCL-A affect the Desired outcomes of CCL-B. | expected outcome:  - HO failure is < 2 %  Actions:  - Entity: gNB-g1  - Change: reduce CIO {to reduce chances of HO failure} | expected outcome:  - SINR > 10 dB  Actions:  - Entity: gNB‑g1  - Change: lower antenna tilt | By reducing antenna tilt to minimize interference CCL-B affect the HO outcomes that are assumed optima by CCL-A |

The CCL may detect or observe events that identify the possibility of any one of the above conflicts. The conflict can be avoided using information or the policies (e.g. priority) provided by the consumer. The respective information is described in the use cases below. If the conflict actually occurs, the CCL MnS producer should support services to inform MnS consumers the confirmed detected conflicts. This may also include informing MnS consumer about the potential conflict.

### 5.4.2 Use Cases

#### 5.4.2.1 CCL scope conflicts handling – CONF\_01

Each CCL should have specific scopes for which it is responsible. The network may be assumed to be a muti--dimensional space, with say n dimensions, i.e., the network has full scope S of n dimensions including, e.g., time, geography, etc. A CCL is assigned a sub scope D that is only a portion of the network’s scope (illustrated by Table 5.4.2.1-1). Scope assignment is the mapping of CCLs to sub scopes S that are part of the network's full scope. A scope conflict occurs if the scope assigned to a CCL overlaps in an undesirable way with another scope assigned to another CCL. The 3GPP management system should support the capability to coordinate the scope assignment to enable detection and avoidance of potential scope conflicts. The 3GPP management system should also support the capability to coordinate the outcomes desirable for the different scopes to enable detection, avoidance and resolution of conflicts on the CCL’s outcomes for those scopes. It may be desirable to define the full scope space S and a set of scope rules to be used to derive the best scope to be assigned to each CCL. An example rule may be that the defined CCL scope should not overlap. The rules may for example be defined by an operator or can be implementation specific depending on the types of CCLs that are to be configured.

Table 5.4.2.1-1: Example of a network scope-space from which the scope of CCL may be derived

|  |  |  |
| --- | --- | --- |
| Scope dimension | Granularity | Example values to be assigned |
| Time | Seconds, minutes, days | Every hour,  Every Saturday at 2:00 hours |
| Network domains |  | Radio  Core |
| Geography | Region/City | City x  Street y in City x |
| Network Elements | gNB | gNB X |
| Cells | Cell A on gNB X |
| Terminals, e.g. types of users | users |
| Resources | Slices |  |
| Network Function | Virtual Network Function A  Physical Network Function B |
| Transport containers (links, flows, etc.) | an identifiable link,  a specific flow |
| Purpose | The purpose of the CCL | Coverage, Performance, Energy Efficiency, Fault Management, UE specific mobility |

NOTE: Table 5.4.2.1-1 is not complete and can be improved and/or extended as needed. Scope conflicts are only considered actual if the application of the defined scopes results in negative outcomes. The management system should support the capability to coordinate the scope assignment to detect and resolve actual scope conflicts. The CCLs monitor changes in their scope. If the scope is changed, it is desirable for the CCLs to notify the scope assignment MnS consumer of the changes or differences between what was configured and the actual scopes. The scope assignment MnS consumer may then trigger scope conflict evaluation based on the actual scope.

#### 5.4.2.3 CCL Concurrent actions conflicts handling - CONF\_02

Several CCLs may want to execute actions onto the network. It may not be desirable that their actions are executed within the same time frame. For example, if executed so close to one another, their effects will be super-imposed and neither CCL can identify the effect of its actions on the network.

The management system should support the capability for detection of potential concurrent actions conflicts. A coordination entity acting as a supervisory action-critic oversees the actions of the different CCLs may need to receive information enabling the detection of such conflicts. The action-critic functionality takes the responsibility for the end-to-end performance across several CCLs enabling evaluation of cases when the actions of multiple CCLs collide.

For a given CCL, the MnS consumer may need to receive the recommended changes from the CCLs, to evaluate them and see if they overlap with other proposed changes from other CCLs. Where there are likely conflicts and expected undesired impacts, the MnS consumer may propose to the CCLs, the changes that should be undertaken to minimize concurrent changes on the same network resources. The MnS consumer may need to provide feedback to the CCL instance (s) regarding their recommended actions.

In some instances, the conditions in the network may be such that it is not clear which CCL should be triggered, requiring to trigger multiple CCL in sequence. The CCLs may operate in a hierarchy with each CCL having an operational profile indicating the specific level of hierarchy. The MnS consumer that coordinates the execution times of the CCLs needs to configure the appropriate hierarchy for the CCLs. The triggering by a coordination capability based on information from the CCL allows resolution of CCL Concurrent actions conflicts.

#### 5.7.2.3 CCL concurrentmetric-value conflicts handling - CONF\_03

Typically, a CCL whose start is triggered based on conditions, needs to be triggered to run at a specific time and terminate when certain conditions are met, to run when a certain performance threshold is crossed. If triggered independently, there may be conflicts among the CCLs. The triggers for different CCLs to be executed need to be coordinated to avoid conflicts among the CCLs.

The management system should support the capability for avoidance of concurrent metric-value conflicts conflicts. Since each CCL focuses on a smaller scope of the network problem space, several CCLs may need to be executed. For actions in a given network scope, the CCLs can be explicitly scheduled by the management system. Where the scopes overlap, the CCLs need to align the action plans, for example, which action plan to execute and when. There is a need to assess each plan and choose the most appropriate combination of action plan(s) based on the selection policy and then notify the selected action plan(s) to the related CCLs. The MnS consumer may also be notified when it is safe to ignore the conflict. The MnS consumer may configure the criteria for evaluating the severity of conflicts.

#### 5.7.2.4 CCL non-concurrentactions conflicts handling –CONF\_04

When two (or more) CCLs attempt to adjust the same network parameter but with different and contradicting values, the desired actions of the 2 CCL will be in conflict. For example, a CCL assuring throughput of a slice may be scaling-out the virtual resources of the slice. Whereas a CCL minimizing the energy consumption may be scaling-in the virtual resource of the same slice. It can be when the CCLs execute actions at the same time. However, it also happens when the CCLs execute at different times, and the scenario for actions to be separated in time is the more likely than actions occurring simultaneously. casein these conflict scenarios, the network parameter continuously ping-pongs between the two values. Such a conflict may be called an action conflict.

NOTE: A potential conflict can for example be detected if a CCL observed that PMs on a certain object keep flipping between two values. The constant flipping can be an indication that 2 CCL instances are attempting to change the same scope.

The CCL may detect or observe events that identify the conflicts. The conflict can be avoided using some information or the policies (e.g. priority) provided by the consumer. If the conflict actually occurs, the CCL MnS producer should support services to inform MnS consumers the confirmed detected conflicts. It is needed to maximize the avoidance of conflict, including “requesting” information from MnS consumer and to inform MnS consumer about the potential conflict. CCL MnS Producer may also provide recommendations, for updating/deleting the conflicting CCLs, that would result in the resolution of detected conflict. The recommendation for update may include suggestions for modified targets.

Note: The exact information that can be exchanged is not specified in this document

#### 5.7.2.5 CCL non-concurrentmetric-valueconflicts handling – CONF\_05

Two (or more) CCLs configuring different control parameter may all influence the same metric. In other cases, the two CCLs influence two metrics Y1 and Y2 that are couple, i.e., which have a logical relationship between them. E.g. handover (HO) failure and SINR are coupled since a bad SINR can lead to more HO failures. If the two CL desire different values for the metric, or different values for two target metrics Y1 and Y2 but the targets are coupled, the CCLs are in conflict for the metric resulting into a metric-value conflict.

Two target metrics Y1 and Y2 may be coupled such that actions to optimize any of them lead to correlated oscillations/degradations in Y1 or Y2, e.g. Y1 ensuring "HO failure is < 2 %" and Y2 wanting "SINR > 10dB". The correlated oscillations indicate a potential conflict, but the CCLs may not see the oscillations in the metric that is not of their interest. The management system should support the capability for detecting potential metric-value conflicts. An MnS consumer may analyse the correlations to detect the potential conflict between CCL1 and CCL2. The MnS consumer should be able to inform CCL1 and CCL2 about the detected potential conflict represented by the correlated oscillations.

This severity of degradation in the performance metrics of the related CCLs could be the confirmation that a detected potential conflict is an actual harmful conflict. The management system should support the capability for detecting or confirming actual metric-value conflicts. The threshold to determine the severity may be defined by the MnS consumer (e.g. the operator) so that if the degree of degradation is higher than the threshold then it is a confirmed conflict that requires resolution.

The management system should support the capability for avoiding potential non-concurrent metric-valueconflicts. CCLs need to avoid large and frequent changes to network parameters which may affect network stability since they increase the probability of occurrence of conflicts. CCLs should take small smooth changes in the cases where the impact is not so clear and only make the large changes when the CCL is sure that the impact is positive. It is desirable for the CCL to notify to the MnS consumer the planned change, its claimed/predicted performance improvement and reliability/confidence in that action/decision. The MnS consumer may evaluate the claimed performance improvement and reliability/confidence to determine if the action should be allowed or not. The MnS consumer should be enabled notify the decision and possibly the failed criteria to the CCL - to either be executed or to be used to compute better decisions. Based on the inputs, the CCL may update its decision-making and repeat the decision evaluation process. If the CCL has consistently made good large-action-decisions, the MnS consumer should be enabled to inform the CCL that the CCL has consistently made good decisions and achieved its ultimate trust and that no more coordination of its decisions is needed.

The management system should support the capability for resolving detected metric-value conflict. The MnS consumer should be enabled to trigger one or more CCLs to respond to the detected potential conflict. And if the triggered CCLs is unable to resolve that conflict, the CCL should inform the MnS consumer about the failure to resolve the problem. The MnS consumer can set the thresholds for performance degradation that triggers conflict detection and resolution.

Note: The criteria for accurately setting the thresholds for performance degradation is not specified in this document.

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### 5.4.3 Requirements

Table 5.4.3-1

| Requirement label | Description | Related use case(s) |
| --- | --- | --- |
| **REQ-CONF\_01-01** | The 3GPP Management System should support a capability to detect and inform an authorized MnS consumer about a potential or actual CCL scope conflicts. | **CONF-CONF\_01** |
| **REQ-CONF\_01-02** | The 3GPP Management System should support a capability to confirm a potential CCL scope conflict as an actual CCL scope conflict and inform an authorized MnS consumer about a confirmed actual CCL scope conflict. | **CONF-CONF\_01** |
| **REQ-CONF\_01-03** | The 3GPP Management System should support a capability to avoid or resolve a CCL scope conflict that has been detected | **CONF-CONF\_01** |
| **REQ-CONF\_01-04** | The 3GPP Management System should support a capability to coordinate the resolution of CCL scope conflicts among multiple CCLs | **CONF-CONF\_01** |
| **REQ- CONF\_02-01** | The 3GPP Management System should support a capability to detect and inform an authorized MnS consumer about a potential CCL concurrent actions conflict. | **CONF-CONF\_02** |
| **REQ-CONF\_02-02** | The 3GPP Management System should support a capability to confirm a potential CCL concurrent actions conflict as an actual conflict and inform an authorized MnS consumer about the confirmed actual CCL concurrent actions . | **CONF-CONF\_02** |
| **REQ-CONF\_02-03** | The 3GPP Management System should support a capability to avoid or resolve a CCL concurrent actions conflict that has been detected | **CONF-CONF\_02** |
| **REQ-CONF\_02-04** | The 3GPP Management System should support a capability enabling the MnS consumer to configure a hierarchy of a CCL | **CONF-CONF\_02** |
| **REQ-CONF\_03-01** | The 3GPP Management System should support a capability to detect and inform an authorized MnS consumer about a potential or actual CCL trigger-time conflicts. | **UC-CONF\_03** |
| **REQ-CONF\_03-02** | The 3GPP Management System should support a capability to confirm and inform an authorized MnS consumer about a detected CCL trigger-time conflict after it is confirmed. | **UC-CONF\_03** |
| **REQ-CONF\_03-03** | The 3GPP Management System should enable authorized MnS Consumer to provide information that can be used to support a capability to avoid or resolve a CCL trigger-time conflict. | **UC-CONF\_03** |
| **REQ-CONF\_04-01** | The 3GPP Management System should support a capability to detect and inform an authorized MnS consumer about a potential action conflict. | **UC-CONF\_04** |
| **REQ-CONF\_04-02** | The 3GPP Management System should support a capability to confirm and inform an authorized MnS consumer about an actual action conflict. | **UC-CONF\_04** |
| **REQ-CONF\_04-03** | The 3GPP Management System should enable authorized MnS consumers to provide information that can be used to resolve a CCL action conflict. | **UC-CONF\_04** |
| **REQ-CONF\_04-04** | The 3GPP Management System should enable authorized MnS consumers to provide information that can be used to avoid the action conflict. | **UC-CONF\_04** |
| **REQ-CONF\_04-05** | The 3GPP Management System should support a capability to coordinate the resolution of CCL action conflicts among multiple CCLs | **UC-CONF\_04** |
| **REQ-CONF\_05-01** | The 3GPP Management System should support a capability to detect and inform an authorized MnS consumer about a potential or actual CCL Metric-value conflicts. | **UC-CONF\_05** |
| **REQ-CONF\_05-02** | The 3GPP Management System should support a capability to confirm and inform an authorized MnS consumer about a detected CCL Metric-value conflict after it is confirmed. | **UC-CONF\_05** |
| **REQ-CONF\_05-03** | The 3GPP Management System should support a capability to avoid or resolve a CCL Metric-value conflict that has been detected | **UC-CONF\_05** |
| **REQ-CONF\_06-01** | The CCL MnS producer should have a capability to indicate to an MnS consumer the set of network functions including their parameters which it is interested in changing | **UC-CONF\_06** |
| **REQ-CONF\_06-02** | The management system should have a capability enabling an authorized CCL instance acting as MnS consumer to receive information on the latest changes to a network function parameter and an identifier of a management entity/function including MDA Function, a SON Function or an AI/ML inference Function that responsible for the change to the parameter. | **UC-CONF\_06** |
| **REQ-CONF\_06-03** | The management system should have a capability enabling an authorized MnS consumer to receive the history of previous values of the parameter, including, for each previous value, the identifier of a respective management entity/function responsible for that change to the parameter. | **UC-CONF\_06** |

## 5.5 CCL decision escalation – ESC

### 5.5.1 Description

This use case related to the capability to escalate decision making to another entity e.g. another CCL.

### 5.5.2 Use Cases

#### 5.5.2.1 Triggering CCL decision escalation – ESC\_01

Not all decisions made by CCLs in different network contexts (states, status, conditions, etc.) are equally effective. The CCL may need to inform another entity about its lack of confidence in its decision with a request to escalate its decision making to that entity. For example, a CCL for optimizing energy saving may fail to decide the sequence in which cells may be deactivated when there is a failure for some cells. The CCL may escalate the scenario to a CCL on problem recovery.

The MnS consumer should be able to configure MnS producer regarding the escalation recipient to which the decision is escalated. The degree to which the CCL can independently execute decisions or escalates them, should be configurable by the MnS consumer through a confidence threshold. The confidence threshold is an index on a fixed scale say from 0 (indicating lowest confidence) to 10 (indicating highest confidence). It could be configured based on the sensitivity of the operations under the CCLs’ control, the trust level in the decisions of the CCL and the necessity to consider a bigger picture at times. Then, based on how much confidence the CCL has in its decisions, the CCL can escalate a decision or situation to an escalation recipient (e.g. another CCL or a CCL coordination entity) which has this bigger picture (say has wider scope), can execute a different(larger) set of actions or has better capabilities, e.g. a larger and more capable ML model.

NOTE: The computation of confidence within the CCL is up to implementation as it depends on the CCL's purpose and the scenario that the CCL is addressing. The escalation recipient CCL should enable the escalator CCL to request for escalation for a given network context or state with e.g. information about the escalator CCL preferences and observed constraints when driving decisions. Based on its evaluations, the escalation recipient CCL should provide to the escalator CCL a report that holds the outcomes for a given escalation request.



Figure 5.5.2.1-1: required interactions for CCL decision escalation

### 5.5.3 Requirements

Table 5.5.3-1

|  |  |  |
| --- | --- | --- |
| Requirement label | Description | Related use case(s) |
| **REQ-ESC\_01-01** | The 3GPP management system should have a capability to enabling an authorized MnS consumer to configure a CCL with the degree of autonomy of to define when the CCL can escalate and the entity to which to escalate decision making. | **UC-ESC\_01**  **Clause 5.5.2.1** |
| **REQ-ESC\_01-02** | The 3GPP management system should have a capability to enabling an authorized MnS consumer (e.g. an escalator CCL) to request to escalate decision-making for a network context or state to an escalation recipient. | **UC-ESC\_01**  **Clause 5.5.2.1** |
| **REQ-ESC\_01-03** | The 3GPP management system should have a capability enabling an escalation recipient CCL to report to an authorized MnS consumer (e.g. an escalator CCL) the outcomes for a given escalation request | **UC-ESC\_01**  **Clause 5.5.2.1** |



\* \* \* Second Change \* \* \* \*

#### 5.4.1.X Alternative CCL coordination Approaches for conflicts handling

To address the conflicts, coordination interactions are required either among CCLs or between the CCLs and one or more higher hierarchy coordination functions to avoid or detect and resolve the conflicts. This is required when CCL are actuating in the same set of resources.

The coordination of CCLs could be accomplished via one of three approaches illustrated by Figure 5.4.1.X-1:

- Distributed coordination with distributed execution (Figure 5.4.1.X-1 a), where the CCLs directly coordinate with one another, and each manages execution of its decisions. The CCL exchange information with each other avoid, detect or resolve conflicts. The information may for example include notifications of executed actions or observed impacts.

- Hierarchical coordination with distributed execution (Figure 5.4.1.X-1 b), where the CCLs coordinate through a separate coordination layer, say via a CCL coordination entity, but each manages execution of its coordinated decisions. The CCL exchange information with the CCL coordination entity to avoid, detect or resolve conflicts. A CCL may send notifications of its executed actions or observed impacts which the CCL coordination entity may relay to other CCLs. The CCL coordination entity may configure the CCLs but each CCL executes its action based the CCL coordination entity’s configuration.

- Hierarchical coordination and execution (Figure 5.4.1.X-1 c), where the CCLs coordinate through a separate coordination layer, say via a coordination entity that besides coordination also manages execution of the coordinated decisions. The CCL exchange information with the CCL coordination entity to avoid, detect or resolve conflicts including notifications of their executed actions or observed impacts which the CCL coordination entity may relay to other CCLs. The CCL coordination entity may configure the CCLs and the CCL execute their actions through the CCL coordination entity.



Figure 5.4.1.X.1-1: Closed Control Loop Coordination approaches

Distributed coordination can lead to too many exchanges between the CCLs which may unnecessarily clog the system. On the other hand, "Hierarchical coordination and execution" implies that too much responsibility is concentrated in a single CCL. A desired behavior is that the individual CCLs are responsible for their own decision execution, so it is recommended that to follow the "hierarchical coordination with distributed execution" approach. In this approach, the CCLs are responsible for making their decisions and executing actions, but they coordinate with the CCL coordinator before, during or after execution.

#### 5.4.1.Y Hierarchical CCL-coordination-interactions for conflicts handling

To address the conflicts, coordination interactions are required between the CCLs and one or more higher hierarchy coordination functions to avoid or detect and resolve the conflicts among goals and their targets, control scopes or actions of the CCLs. The 3GPP management system includes at least one entity called the Coordination entity that undertakes the role of CCL coordination. The Coordination entity can be implemented as a CCL, an AIML inference engine or any other functionality that is found appropriate. The coordination entity may support coordination for conflict management for different conflicts described in clause 5.4.2 including Goal- and Goal-targets- Conflicts; scope conflicts, CCL-Trigger-time and CCL-action-execution-time conflicts, Direct actions conflicts as well as metric-value conflicts.

The coordination of CCLs could be required at different execution points of the CCL translating into different CCL coordination use cases with corresponding CCL coordination services required at those points as illustrated by example Figure 5.4.1.Y-1. The coordination of CCLs could be achieved via direct interaction among the CCLs or via a third-party entity, say called the CCLs coordination Function (or simply CCL Coordinator).



Figure 5.4.1.Y-1: Exemplary Closed Control Loop Coordination interaction points

NOTE: The terms at the top indicate general naming of the groupings of coordination interactions at the different execution points during the execution of the CCL. Action-space coordination implies coordinating the sets of actions that the different CCL can apply. Concurrency control implies coordinating the times at which different CCLs can execute actions. Action-impact assessment indicates interactions and processes on the evaluation of the impacts of the different CCLs.

The coordination purpose attributes contain the information and data needed or used by the coordination entity for interacting with the CCL when handling conflicts.