Qatar Mobility Innovations Center

# A Framework for Classification of Self-Organizing Network Conflicts and Coordination Algorithms

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# Key information

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- This talk was given at IEEE PIMRC-2013,(http://www.ieee-pimrc.org/2013/) London, to present a paper:

‘Hafiz Yasar Lateef, , Ali Imran, Adnan Abu-dayya, **‘A Framework for Classification of Self-Organising Network Conflicts and Coordination Algorithms**‘, *In Proceedings of IEEE Personal Indoor and Mobile Radio Communications (PIMRC’ 2013)*, pp. 2913 –2918, 2013.

- The associated paper is downloadable from: http://qson.org/category/publicationsdownloads/

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# Outline

- **The Transition From Conventional Network Operation to Self-Organizing Networks (SON)**
- **Self-Organizing Functions Interdependencies & Conflicts**
- **Self-Coordination Framework**
- **Trigger-Condition-Action Policy for MRO & MLB**
- **Future Work**

# Conventional Cellular Networks

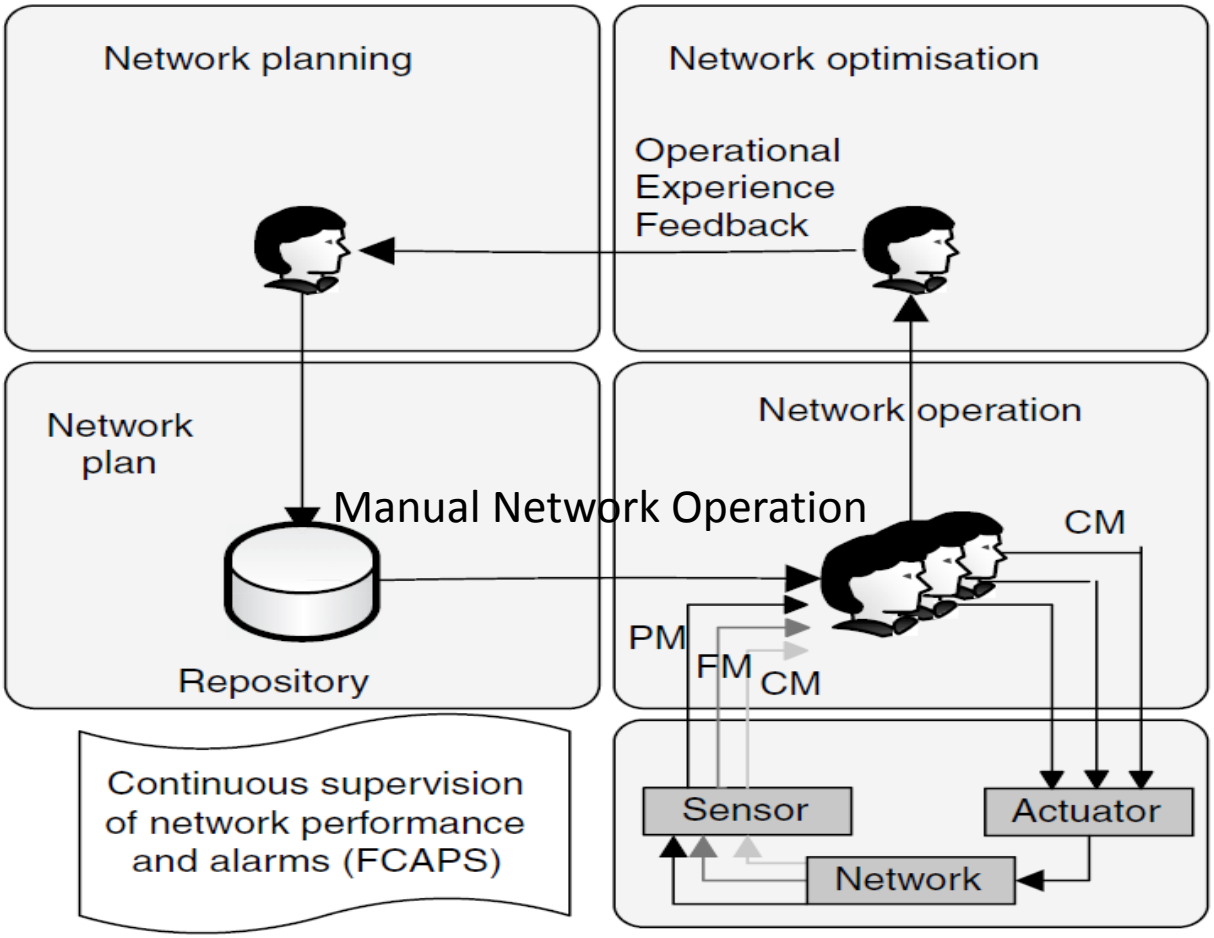



Fig. 1. Manual Network operation of Cellular Networks (Courtesy of [7])

# Next Generation Cellular Networks

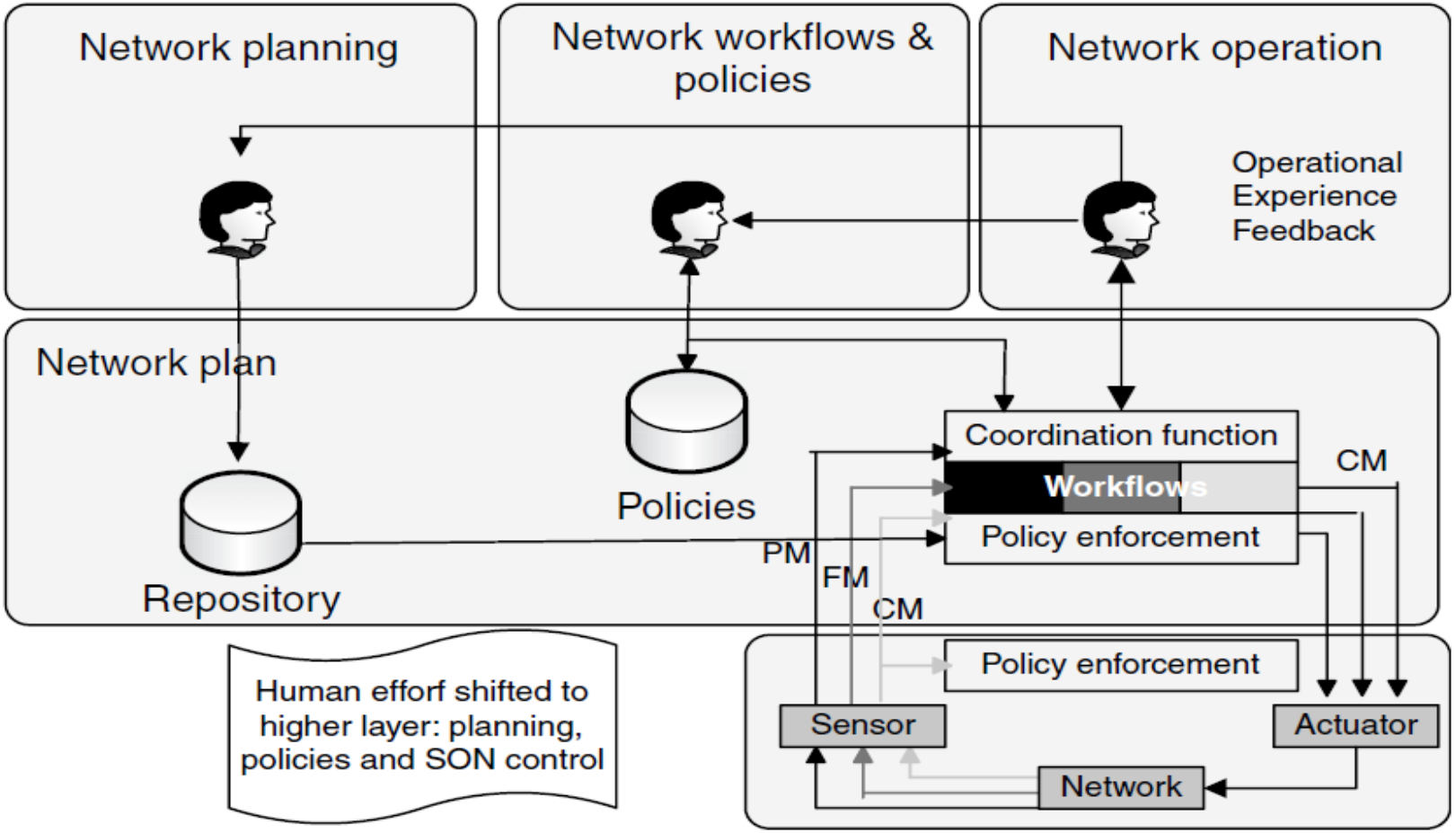



Fig. 2. Network Management with Closed-Loop Automation (Courtesy of [7])

# SON Standardisation in 3GPP

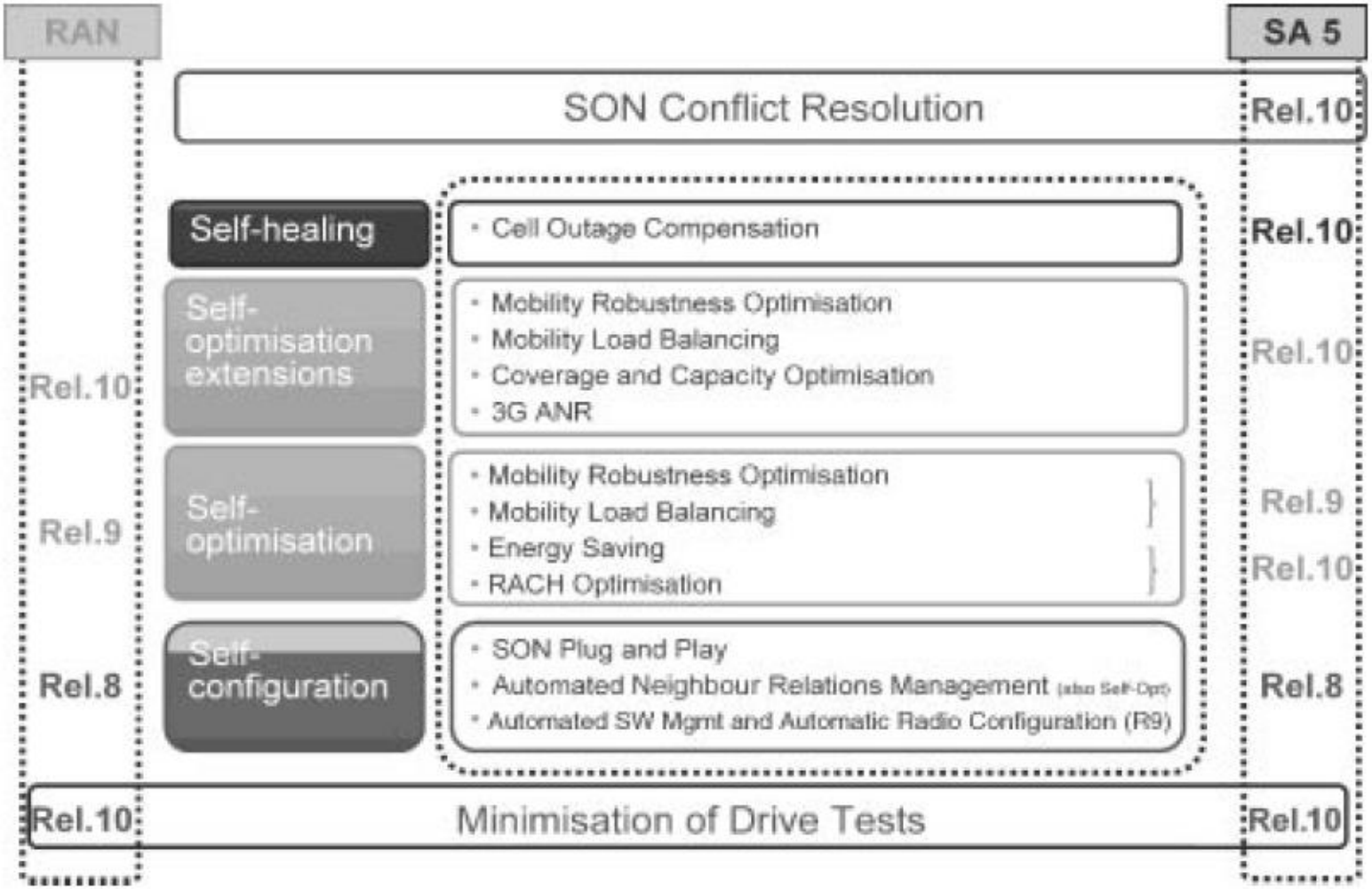



Fig. 3. Roadmap for SON Standardisation in 3GPP [7]

# Self-Organising Functions Inter-Dependencies

- SO functions may have complex relations and parameter/logical inter-dependencies which can induce conflicts among SO functions and eventually undermine the network operation.

- Therefore, coordination among SO functions is essential for not only to avoid objective/parameter conflicts but also to ensure the stable operation of wireless networks.

- It is also vital to figure out the optimum way of designing Self optimization algorithms in conjunction with self co-ordination for efficient radio resource management and reduced operational expenditures (OPEX).

# Self-Organising Function Conflicts

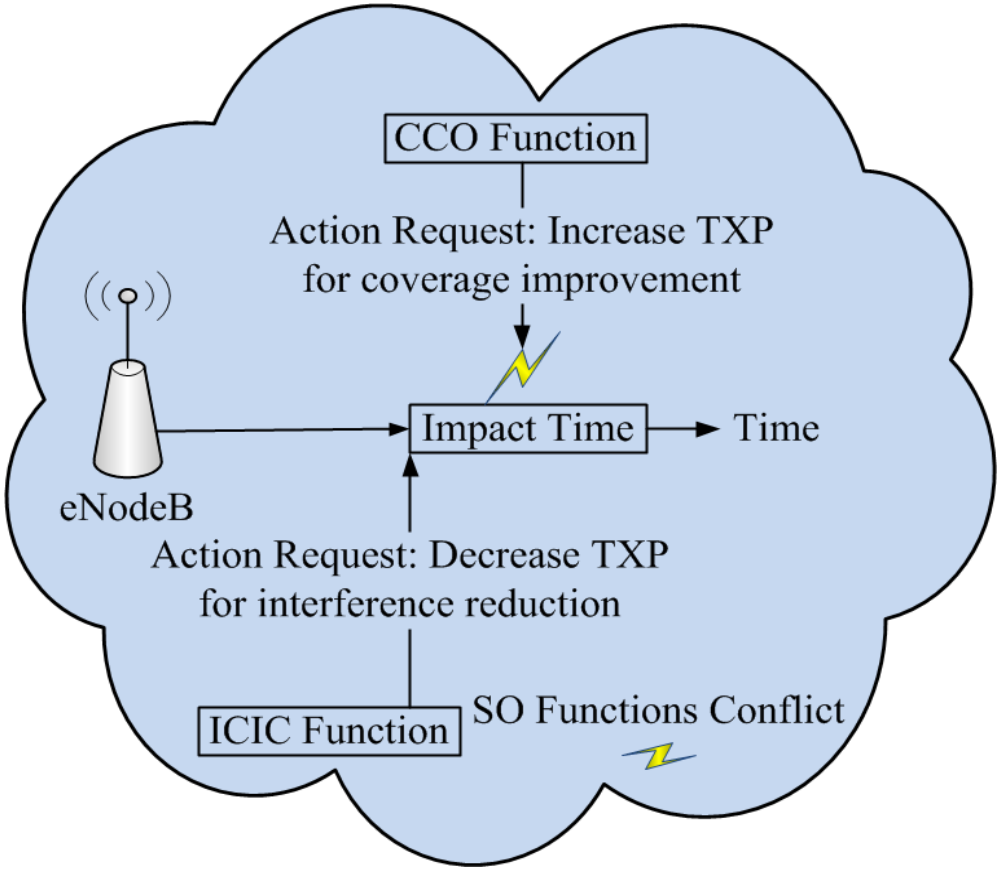



Fig. 4. Conflict between CCO & ICIC SO functions.

# SON Conflicts Classification

- **In this paper we present a comprehensive classification of SO function conflicts, which leads the way for designing suitable conflict resolution solutions among SO functions and implementing Self-Organising Network (SON) in reality.**

- **SO functions conflicts are categorised into the following five primary categories:**
- **(A) Key Performance Indicator Conflict;**
- **(B) Parameter Conflict;**
- **(C) Network Topology Mutation Conflict;**
- **(D) Logical Dependency Conflict;**
- **(E) Measurement Conflict.**

# SON Conflicts Classification

## (A) Key Performance Indicator Conflict;

- KPI conflicts may occur when different SO function actions alter the same KPI of a cell while adjusting different parameters of that cell. An example of a KPI conflict is given below.
- **CCO Remote Electrical Tilt (RET) and CCO Transmission Power (TXP) Conflict**: The alteration of both, downlink TXP and RET, influences the coverage area of a cell and can cause a KPI conflict.

# SON Conflicts Classification

## (B) Parameter Conflict

- Parameter conflicts arise from contradictory changes to network parameters by SO functions.
- **CCO and Energy Efficiency (EE) Functions Conflict:** EE function may try to reduce Evolved Node B (eNB) TXP or try to activate sleep mode at eNB for energy saving, while CCO function may try to increase TXP for better coverage. Hence, both EE & CCO try to set different output values for TXP of eNB and subsequently cause output parameter conflict.

# SON Conflicts Classification

## (C) Network Topology Mutation Conflict

- Network topology mutation conflict may occur due to the change in network conditions by the addition/ removal of eNB, Home eNB (HeNB) or Relay. The details of NTM conflicts are provided in the following examples.
- **New eNB/ HeNB/ Relay and CCO:** CCO function may configure optimum settings of TXP and RET for coverage improvement. However, the addition of new eNB/ HeNB/ Relay will have an impact on the coverage area and, as such, CCO function may need to readjust the optimum settings for coverage area. Moreover, HeNBs are frequently switched on/off or relocated, which will continuously disturb the optimum configuration of CCO function.

# SON Conflicts Classification

## (D) Logical Dependency Conflict

- This may occur if there is a logical dependency between the objectives of SO functions.
- **MLB and EE Functions Conflict:** EE function may change TXP or RET in order to improve energy efficiency. However, these changes will modify the cell size and, as a result the hysteresis threshold calculated by MLB might be erroneous.

# SON Conflicts Classification

**(E) Measurement Conflict**

- This may occur if a SON function is either triggered or computes new parameter values based on outdated measurements.
- **MRO and COC Functions Conflict:** COC function can modify RET in order to compensate for cell outage, which will have impact on the cell size. Meanwhile, if a MRO function is triggered based on measurements collected before the change in cell size, then the MRO function could be using outdated measurements for calculating new handover settings.

# Classification of Precedent SO Functions Conflicts

| Sr. No. | Precedent Conflict Scenario | Conflict Category |
|---|---|---|
| 1 | MRO and MLB | Output Parameter Conflict |
| 2 | Two PCI Instances | Input Parameter Conflict |
| 3 | MRO and CCO | Measurement Conflict |
| 4 | CCO (RET & TXP) | KPI Conflict |
| 5 | MLB and CCO | Logical Dependency Conflict |
| 6 | CCO and PCI | Logical Dependency Conflict |
| 7 | COC and PCI | Logical Dependency Conflict |

# Classification of Forefront SO Functions Conflicts

| Sr. No. | Forefront Conflict Scenario | Conflict Category |
|---|---|---|
| 1 | CCO and EE | Output Parameter Conflict |
| 2 | CCO and COC | Output Parameter Conflict |
| 3 | CCO and ICIC | Output Parameter Conflict |
| 4 | MRO and COC | Measurement Conflict |
| 5 | MLB and COC | Logical Dependency Conflict |
| 6 | MLB and EE | Logical Dependency Conflict |
| 7 | MRO and PCI | Logical Dependency Conflict |
| 8 | MLB and PCI | Logical Dependency Conflict |

# Classification Of Conflicts Between SO Functions And New eNB/ HeNB/ Relay

| Sr. No. | Conflict Scenario | Conflict Category |
|---|---|---|
| 1 | New eNB/ HeNB/ Relay and CCO | NTM Conflict |
| 2 | New eNB/ HeNB/ Relay and EE | NTM Conflict |
| 3 | New eNB/ HeNB/ Relay and MRO | NTM Conflict |
| 4 | New eNB/ HeNB/ Relay and MLB | NTM Conflict |
| 5 | New eNB/ HeNB/ Relay and ANR | NTM Conflict |

- NTM: Network Topology Mutation

## Self Co-ordination Mechanisms

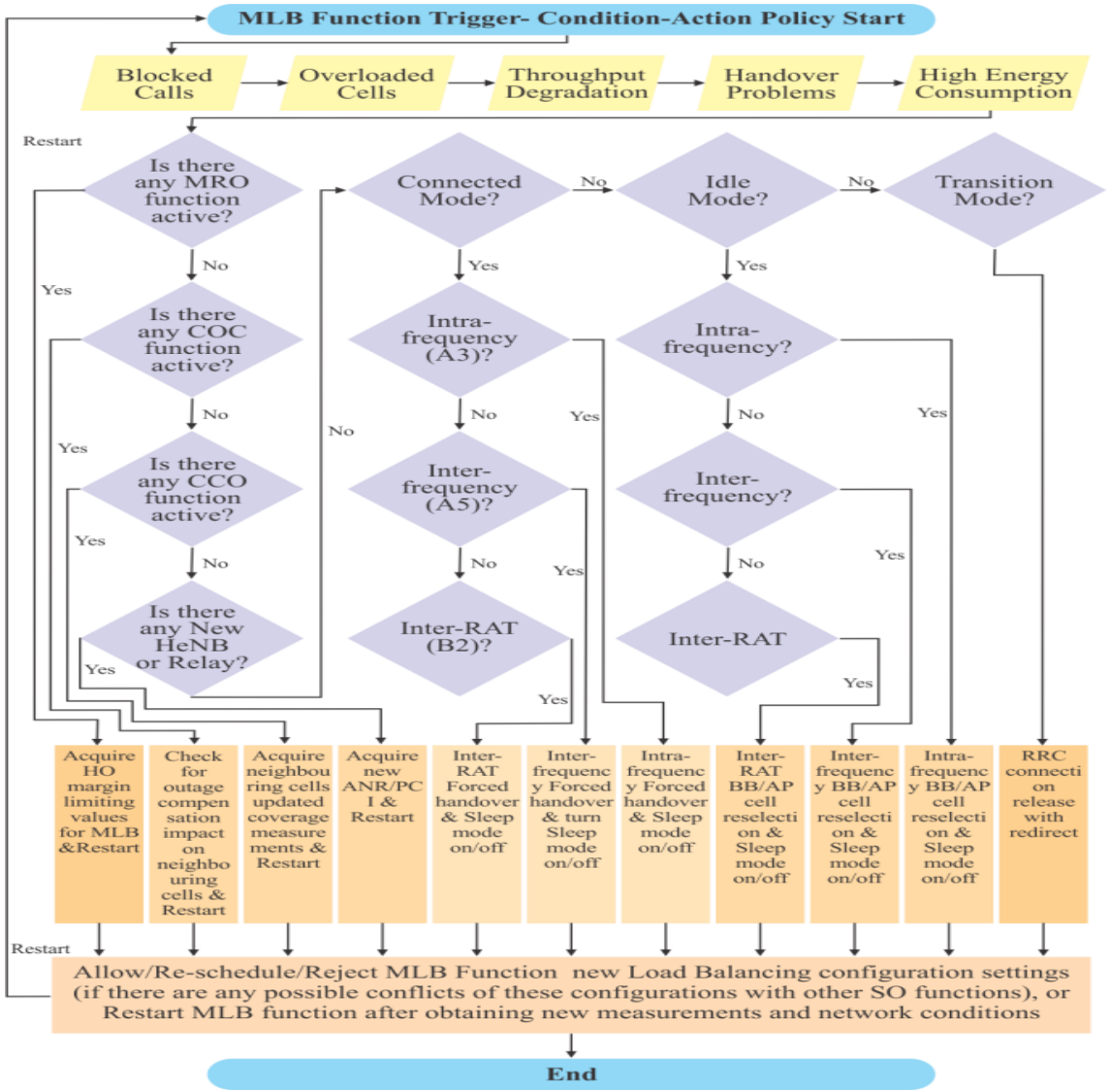
| Self Co-ordination Mechanisms | Mechanism Approach |
|---|---|
| Policy Functions | Policies are derived from operator requirements and consist of a set of constraints on the network behaviour. |
| Workflows | Workflows consist of a set of activities to accomplish SO goals according to a set of procedural roles. |
| Decision Tree Logic | Decision trees provide a sequence of conditions that need to be evaluated to take a coordination decision in response to a SON function execution request. |
| Autogonistic Function | Autognostics function collects and processes performance, fault and configuration data as input to the SON system |
| Alignment Function | The Alignment function monitors output parameter configuration requests from SO functions & it rejects or reschedule the requests in case of conflict between SO goal or parameter value. |
| Co-design | Co-design function combines the goals of multiple SO functions into a single optimisation function that optimizes multiple parameters simultaneously. |
| Guard Function | The Guard function detects extreme or undesirable network behaviour and triggers countermeasures. |
| Parameter Locks | A SO function configuring a parameter may lock this parameter for a certain period of time to prevent other SO functions to modify this parameter negatively. |
| Algorithm Co-ordination | The algorithm coordination function operates on the algorithm execution request, which allows it to take coordination decisions before the algorithm execution. |
| Action Co-ordination | In action coordination, SO functions send requests to coordination function to execute its action and only in case of an acknowledgment the actions are triggered. |

# Trigger-Condition-Action Policy

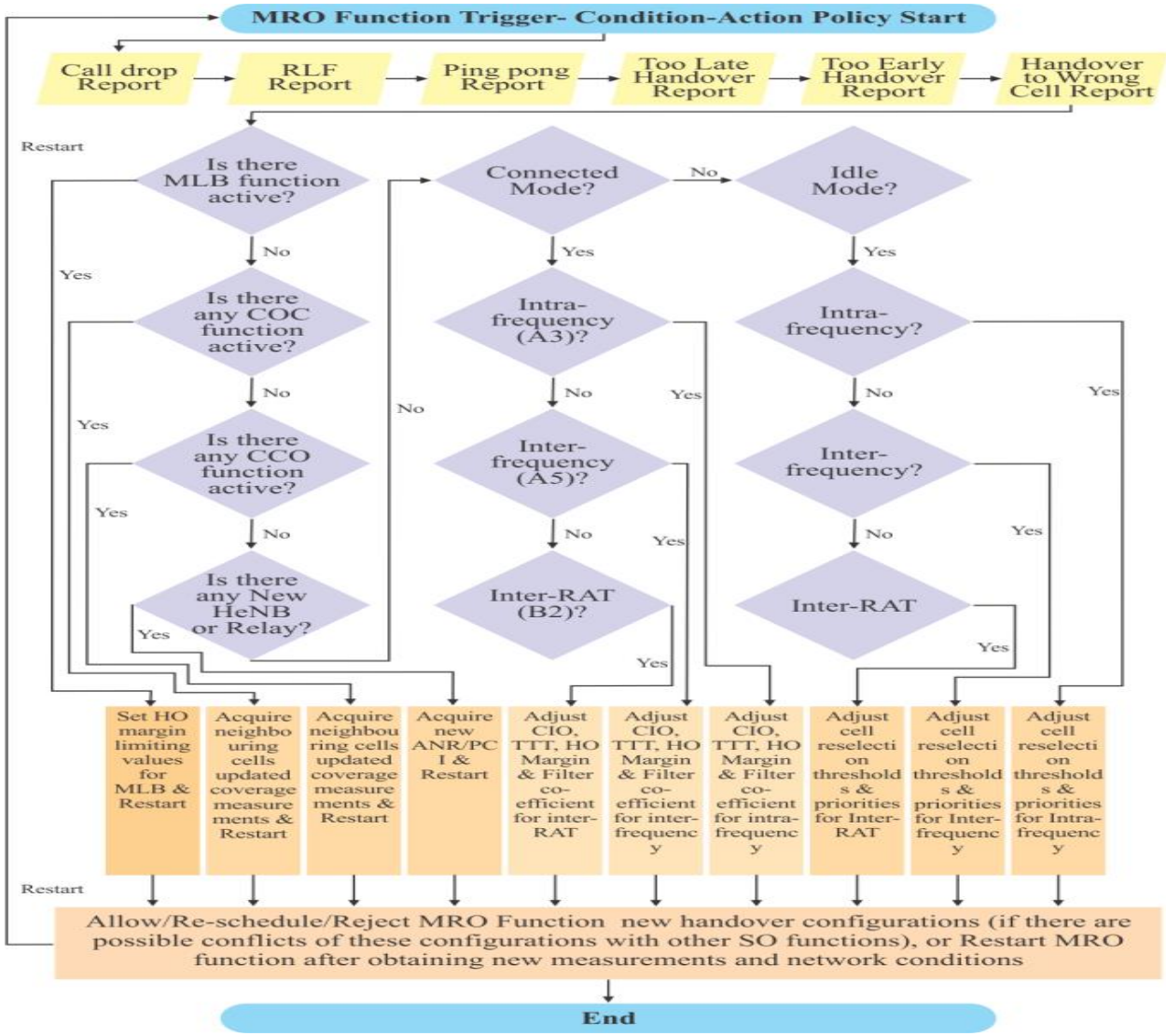
- **Trigger-Condition-Action (TCA) based policy is quite useful in designing conflict free SO functions as it provides a holistic picture of all the possible triggers, SO functions conflicts, necessary conditions to be checked and the corresponding actions to be executed.**

- **TCA policies are the keys to design conflict free "decision tree logic" or "joint optimisation algorithms" for SO functions such as MRO, MLB, CCO and EE.**

# MLB Trigger Condition-Action Policy



# MRO Trigger Condition-Action Policy



# Future Research Challenges

- Most of the previous research work has focused on intra-frequency connected mode handover condition for MRO.
- However, MRO function for inter-frequency, inter-RAT handover conditions in both connected and idle mode has been unrevealed.
- More specifically, optimum configuration of CIO, TTT, filter co-efficient, cell reselection thresholds and priorities for inter-frequency, inter-RAT handover conditions in both connected and idle mode needs to be identified.

# Future Research Challenges

- It must be mentioned here that most of the previous research work has focused on intra-frequency connected mode mobility load balancing.

- However, MLB function for inter-frequency, inter-RAT cases in connected, idle and transition mode has been unrevealed.
- More specifically, optimum configuration of CIO, TTT, filter co-efficient, BB thresholds and absolute priorities for inter-frequency, inter-RAT mobility load conditions in connected, idle and transition mode needs to be identified.

# Optimum Interactions Between Self Optimisation & Self Co-ordination Functions

- **If self optimisation and self co-ordination functions are executed independently, then the algorithm part of self optimisation functions will always be executed irrespective of the subsequent acknowledgment or rejection of the action request by the Self Co-ordination function.**

- **Moreover, based upon the rejected action requests, numerous self optimisation algorithms might have been executed without any performance gains.**

- **The above mentioned facts drive for finding optimum interactions between self optimisation and self co-ordination functions.**

## Classification of Co-ordination type in Conflict Categories

| Conflict Category | Preferred Co-ordination Type |
|---|---|
| Parameter Conflict | Co-design or decision tree logic or Algorithm Co-ordination or TCA based policy functions |
| Measurement Conflict | Algorithm Co-ordination |
| KPI Conflict | Action Co-ordination or Algorithm & Action Co-ordination or parameter locks or Guard function or alignment function |
| NTM Conflict | Action co-ordination |
| Logical dependency Conflict | Action Co-ordination |

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# Thank You!