Project	**IEEE P1900.4 WG** http://www.ieeep1900.org/
Title	**"Information Model" text for Information Model main chapters of the baseline document**
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Source(s)	Klaus Nolte, Oliver Holland, Alireza Attar, Tim Farnham, Mahesh Sooriyabandara, Makis Stamatelatos, Costas Polychronopoulos, Stanislaw Filin, Homare Murakami, Kentaro Ishizu, Soodesh Buljore,. Alcatel-Lucent, KCL, Toshiba, UoA, NICT, Moto Entities of the Info Model SG: Alcatel-Lucent, Cosmo Research, Hitachi, ISB, KCL, Motorola, NICT, Pultek, TREL, UoA
Re:	IEEE P1900.4
Abstract	This documents considers the scope and content of the information model
Purpose	Text proposal for the baseline document chapter on information model
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Part(s) of the P1900.4 D1.2 (approved in Berlin) addressed by the document?

Please tick the section of the Baseline Document D1.2 addressed by this contribution.

4. System Architecture *Overall system architecture with main interfaces (subject to standardization) between the building blocks. Note: in this section generic interfaces should be considered only.*	
5. Use Cases	
5.1 Dynamic Spectrum Allocation	
5.2 Dynamic Spectrum Access	
5.3 Distributed Radio Resource usage optimization	
6. General System Requirements *This section contains a) generic requirements (use-case agnostic or common to all of the use cases). Note: the nature of this section (text only AND/OR high level modeling should be defined during the course of document "development".*	
7. Functional baseline Architecture	
7.1 Dynamic Spectrum Allocation design realization	
7.2 Dynamic Spectrum Access design realization	
7.3 Distributed Radio Resource usage optimization design realization	
8. Information Model and Representation	✓
9. Procedures *This section contains the procedures the TRM should follow in order to "consume" the information (of section 8) conveyed of the radio enabler. This section should also capture the behavior of the TRM with respect to the policies. Note: Working assumption: The protocol aspects are considered to be informative and should be taken into account by the protocol task group which will design the actual protocol.*	

9.1 State Diagram(s)	
10. Annex	
Other : *(please detail)*	

Progress since DC meeting:

- **Adopted a simple and clean structure as proposed during the face-to-face meeting**
- **Rewritten almost all the sections by reusing the text already in the baseline document -- Removed outdated text and descriptive material.**
- **Class diagrams were slightly modified (New classes and updated relationships) to provide a more complete picture**
- **Addressed most of the comments received from NICT team on the -8-07-47r5 document**

Note: Proposed text is mostly normative. This contribution intended to replace the existing text in the chapter 9 of the document

Text Begin

9 Information Model Requirements

The information model is based on the following requirements:

Information Model should be developed in an extensible form in order to accommodate future radio access technologies and allow for custom extensions to existing data models.

Information Model shall support sufficiently simple relationships between different classes.

Information Model may include both uniform and non-uniform data structures (e.g., lists). Information Model may define new abstract data types to describe the information model items.

Information Model may provide information items allowing for specification of precision and accuracy.

Information Model may include time/duration reference related to the validity of the provided information. For instance the time at which measurements were made or valid period in which they are to be taken.

Information Model shall include exclusivity or consistency relationships between objects to determine conflicts – for instance whether two different channels or radio technologies can be monitored at the same time.

Information Model shall provide means for unique identification of managed objects.

Information Model shall utilize platform-independent unambiguous information/data type definitions.

Information model may include information about information objects distribution (e.g. to identify the targeted nodes to a multicasting case).

Information Model should incorporate corresponding information elements towards developing a shared knowledge framework about the information objects themselves. Such framework may include information about the objects local storage, updates, status etc.

Information Model should incorporate a notifications list, such as alarms, configuration changes security events etc to align the shared knowledge framework.

Information Model may incorporate additional information elements to ensure alternative information retrieval for back-up or for supporting an efficient retrieval mechanism to obtain performance, QoS and related information and measurements data.

Information Model should incorporate information elements that can provide value (instantiate) through mechanisms such as statistical operations to reduce data transfers.

Information Model should provide geo-location related information items.

Information Model shall include managed object(s) in order to coordinate the measurements scheduling.

10 Information Model

10.1 Introduction

A specified representation of information, within the scope of the outlined system architecture, is required to realize the distributed radio resource management use cases described in section X and Annex X. P1900.4 uses an information model based on an object-oriented approach, whereby given that RANs and terminals are controlled by P1900.4, they are viewed as the two sets of managed objects [X ref to managed objects]. To this end, the terminal classes abstract the user, application and radio link concepts, for instance structuring different profiles, policies and context information related to the terminal and radio links. The RAN classes present an abstract view of the RAN, capturing the operator, cell, and BS related configuration and context information.

There is often a need to represent common classes which may be utilized by a variety of elements. Within P1900.4, there are two types of common classes: policy classes, and utility classes. Policy classes are a fundamental part of this standard ensuring the provision of policies to terminals to outline the constraints on their operation. P1900.4 therefore presents a robust representation of events which trigger policies, the conditions within which policies must act, and the precise actions which must be undertaken should, for example, a terminal be found violating a policy. Examples of utility classes include how the information itself is represented (e.g., thresholds), or how measurement reports are obtained from objects.

In summary, the classes of the information model are grouped into the following categories:-

- Terminal classes,
- RAN classes,
- NRM classes,
- Common classes,
    - Policy classes,
    - Utility classes.

For each of these categories, the associated class hierarchies are described in this section. An informative Annex gives examples of the utility classes, which are not IEEE P1900.4 specific, but may be required to implement the data model.

10.2 Terminal related classes

As described in the functional architecture in the section 6.2.2, the Terminal Reconfiguration Manager of P1900.4 system consumes information about the terminal when making a reconfiguration decision according to the NRM provided policies. Terminal Class model enables efficient management of radio resources at the terminal level through the corresponding managed object classes.

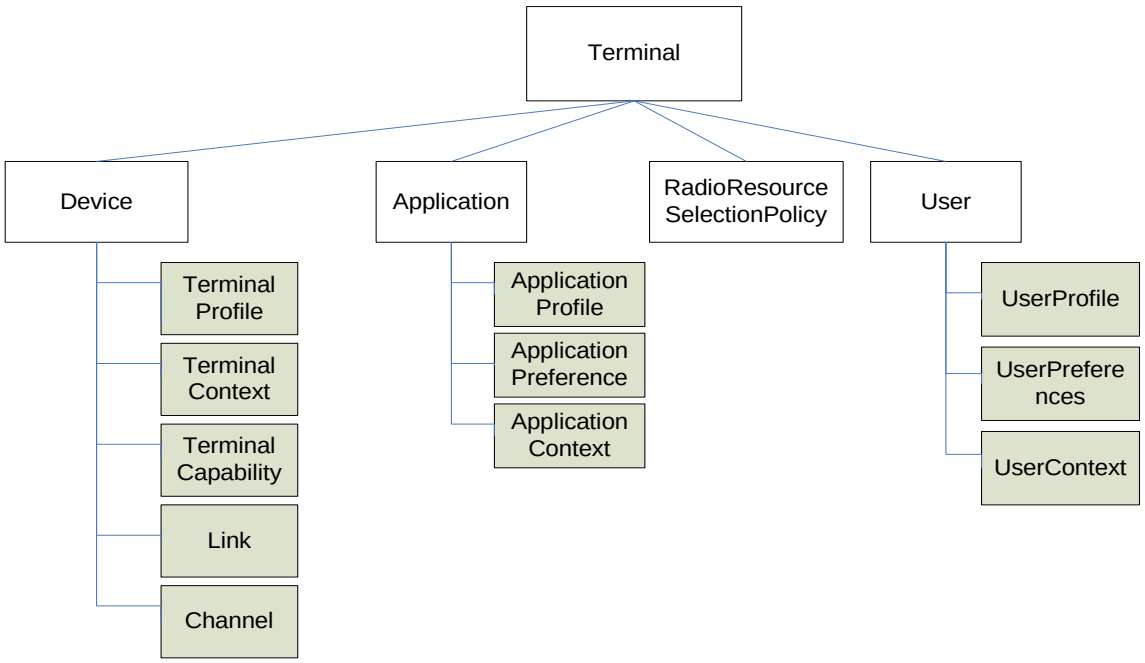

Figure 1: Terminal related information.

The hierarchy above introduces a number of managed objects within the CR terminal. Information at the terminal level is abstracted based on four distinctive concepts associated with the terminal, namely, device, application, RRS policy and User. Each category is described using a set of classes covering information related to dynamic radio resource management at the terminal, which will be exposed to the NRM. The following terminal classes are described within the standard. Refer to Annex X, for additional information about the class structures, attributes and relationships between terminal classes.

- **Terminal**: This is the root class of the terminal class model. An instance of the Terminal is the root managed object containing all other managed objects related to this terminal. This object will use a unique identifier to identify the terminal.
- **Device**

  This contains a set of classes describing configuration and measurement information related to the radio resources within a terminal.

  - **Terminal Profile**: This provides information about available configuration modes.

- **Terminal Context**: This corresponds to information about the current status of the terminal. Status could be described using environmental parameters, performance indicators and/or current configuration governing the behaviour or operation of the system.
- **Terminal Capability:** This describes the set of capabilities of the terminal.
- **Link:** This describes available links within a terminal, possible options available to it, and also the configuration specific to available networks. This also contains the performance information of active links used by the terminal for instance BER, and SNR information. .
- **Channel**: The Channel class abstracts radio resources that can be used by radio devices and a channel may be characterized in the frequency, time and space domains. This contains configuration, measurement and performance information of all the available channels, which can potentially be used by different radio access technologies.

- **Application**

  This contains a number of classes specifying information required for radio resource management decision making process.

  - **Application Profile**: This contains information that characterises the application and also include strict QoS requirements need for normal operation of the application
  - **Application Preferences**: The preferences are expectations of the applications described using QoS attributes. Generally, they indicate application's ability to adapt resource consumption or different performance or service levels
  - **Application Context**: This characterises application performance and behaviour through measurements and environment details.

- **Radio Resource Selection Policy:** This type of policy is derived from the common policy class defined in section YYY. In particular, it describes RRS policy will define set of rules governing the reconfiguration of radio.

- **User**

  User is a container which includes classes that describe the subscription and other information about the user useful for making decisions about the radio resource configuration.

  - **User Profile**: This is identification of different users and their service level agreements, for instance described using privilege level and access/service rights information.
  - **User Preferences**: This is for storing preferences of different users of the terminal describing their expectations from the communication service.

- **User Context**: This information is indicative about relative user satisfaction, for instance this will provide feedback on user perceived performance.

10.3 RAN related classes

As regards managed objects in RANs, which can be considered as the highest level of the managed object hierarchy, the following classes apply.

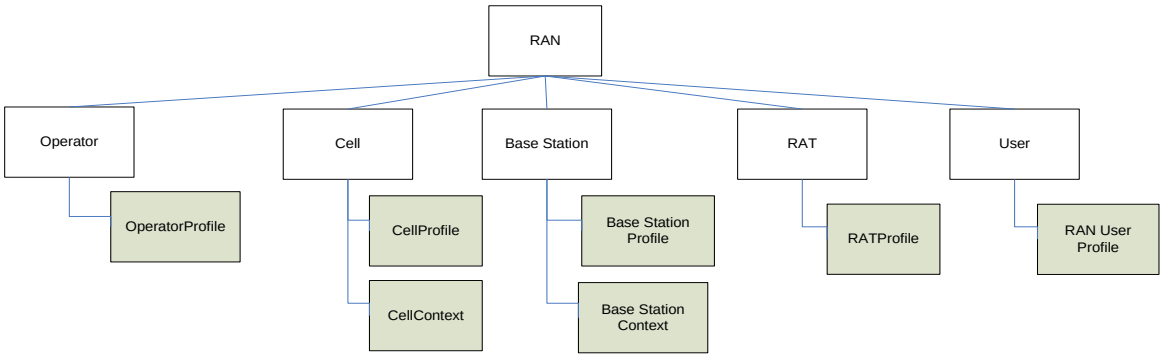

Figure 2: RAN related information.

- **RAN:** Object containing/aggregating all RAN-related objects.
- **Operator:**
  - **Operator Profile:** This object provides profile information about the Network Operator. As depicted in the model, an Operator may own/operate a number of RANs. It might include an identifier for the operator, the allocated frequency bands, and, for example, information about the provided services and the corresponding cost. It can also include information regarding operator objectives regarding radio resource usage optimization.
- **Cell:**
  - **Cell Profile:** Cell Profile includes the identifier for the cell, the frequency range/band for the cell, the cell location, an identifier for the base station serving the cell, the coverage area of the cell, and information about the potential sectorization. It must be also noted that a base station may support multiple cells. In other words, cell profile describes cell capabilities and configuration.
  - **Cell Context:** Cell context object describing the dynamic aspects of a specific cell. May include an identified for the context, the coverage area, the transmission power of the base station that serves the cell, the cell load, the traffic loss rate, the traffic jitter, the throughput, the latency, and the number of terminals served by the cell.
- **Base Station:** The base station referred to by a cell (the NRM may on behalf of this information get information on restrictions related to the base station as a whole). This may include an identifier for the base station, the name of the vendor of the base station, context information for the base station, the location of the base station, and the cell with which is it associated.

- **Base Station Profile:** This incorporates information about the capabilities of base station and current configuration of that base station. Such information includes for example the antenna configuration, and the supported RATs.
- **Base Station Context:** This incorporates information that is changing in a dynamic fashion for a specific base station. This class is for further study.

- **RAT**
  - **RAT Profile:** RAT object incorporating profile information that is related to a specific RAT. Might include an identifier for the RAT and the type of the RAT, and also the RAN that the RATs are associated with. Profile information about RATs is technology specific, implying different sets of possible dynamic spectrum usage opportunities for different RATs.
- **User**
  - **RAN User Profile**: User profile as known to the network related to service access rights/privileges.

10.4 NRM related Classes

As regards managed objects in NRM, which can be considered as the highest level of the managed object hierarchy, the following classes apply.

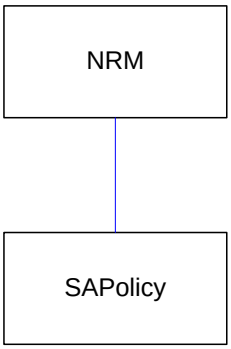

Figure 3: NRM related information.

- **Spectrum Assignment Policy:** This type of policy is derived from the common policy class defined in section YYY. In particular, it describes SA policy will define set of rules governing the reconfiguration of radio.

10.5 Policy Classes

As regards managed objects in NRM, which can be considered as the highest level of the managed object hierarchy, the following classes apply.

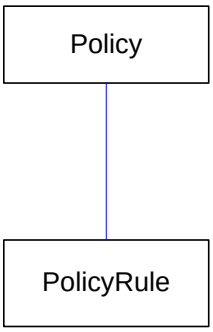

Figure 4: Policy Information.

10.5.1 Specific requirements

To facilitate efficient exchange of information, it is necessary to incorporate common classes to apply the required statistical operations, filters (i.e. selection criteria), trigger thresholds, and other mechanisms that can optimize the efficiency of information exchanges.

10.5.2 Policy classes

- **Policy Rule:** Policy rules in P1900.4 are classes are constructed of "event-condition-action" triplets. The "event" part specifies the event that triggers the policy to be acted upon. For instance, an "event" might be a transmission power threshold being violated by a terminal. The "condition" part is a collection of conditions, which might be optionally specified, that must be satisfied in order for the policy to be acted upon. Such conditions are equivalent to "if" statements, whereby various logical operations might also be employed among the conditions. The "action" part specifies the action to be undertaken should both "event" and "condition" be satisfied. For instance, an "action" might be "reduce the transmission power by 3dB".
- **Policy:** In addition to raw policy rules, P1900.4 may specify "policies". These are collections of policies that act in combination.