Implementing an Enterprise Business Context Model for Defining Mobile Broadband Policy

Rebecca Copeland, Core Viewpoint Ltd, Kenilworth, United Kingdom (Author)

Noel Crespi, Telecom Sud-Paris, Evry, Paris, France (Co-Author)

Abstract—This paper proposes a practical model for non-Telecom staff to determine enterprise-Business-Context (eBC) status for employees' service requests. This is used to grant selective funding for business usage, which is distinguished from unfunded personal usage. The eBC Model interprets enterprise objectives via layered prioritization. It computes the eBC status from dynamic Attributes, grouped into Factors that characterize the Task context. We built the eBC Model with typical Task Templates and representative scenarios. The simulation results proved the eBC Model to be robust, flexible and easily customizable by non-Telecom people.

Keywords-Policy; Context; BYOD; PCC; Policy Decision; Roles; Attributes; RBAC; ABAC; SAW; MADM

I. Introduction

A. *The Enterprise Business Context (eBC) Model*

The purpose of the eBC (enterprise Business Context) based solution is to enable the enterprise to make service delivery decisions where work and leisure blend inextricably. Enterprises embracing BYOD (Bring Your Own Device) permit employees to use personal devices for business. The enterprise has to selectively reimburse communication expenses and protect its internal networks from excessive personal usage by smart devices that consume vast network resources. The enterprise also aims to curb business usage and influence employees' behavior, e.g. when and where to allow streaming video, what is allowed for home working and extra-curriculum activities during work time.

With eBC, the enterprise can provide consistent policies regardless of the delivering network and directly refund employees' expenses. Business policies vary greatly between enterprises and need to be often modified, so they must be easily managed by administrators who have no Telecom expertise. Further use of the eBC Model could bring great savings to the enterprise by selecting the optimal access network, i.e. force-on-net (to the internal LAN/WLAN) for business requests and force-off-net for personal usage requests. Another cost-saving action can be to offer an alternative media type instead of rejecting the session. Selectively applying appropriate level of security to business sessions is another way of reducing costs by using the eBC Model.

The enterprise has access to internal and confidential context data that it cannot divulge to carriers. This data provides valuable insights that enable the enterprise, and only the enterprise, to evaluate the context for the user's service request and make appropriate funding decision. Using eBC, the enterprise can generate suitable session parameters and convey them according to standard 3GPP PCC (Policy & Charging control) rules. To do that, the eBC Model has to link business objectives and network policies. This entails automation of a process that transforms human perceptions of context and priority into precise service delivery instructions.

In this paper we propose a computational eBC Model, which is part of the eBC Function, as shown in Figure 1. The eBC Function contains service request management and a policy engine as well. It extracts context data and aggregates it into 'Attributes'. The eBC Model is the component that determines the eBC status and identifies the required PCC rule.

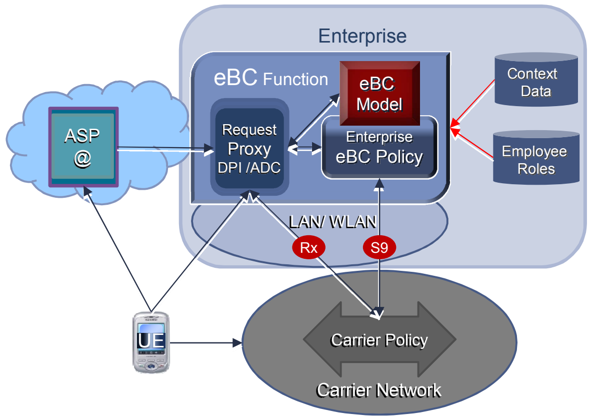

Figure 1. The eBC model in Network context

The eBC Model has to ascertain unambiguously whether the employee is engaged in a refundable activity that the enterprise will pay for. If eBC status is not granted, the service request is handed over to the carrier, to connect under the user's personal subscription. This selective funding can be implemented via 'service sponsoring' agreements with carriers, where the sponsored session request is forwarded to the employee's carrier via the Rx interface. If the enterprise has an MVNO (Mobile Virtual Network Operator) agreement, the eBC results are used further to define the levels of service quality, which are translated to specific network policy rules and sent via the S9 interface.

B. *Related work*

Related papers discuss various aspects of eBC: In [21], the eBC concept is introduced with the motivation of carriers and enterprises for adopting it, and the solution feasibility via 3GPP MVNO and Sponsoring models is examined. In [22], the detection and interception of service requests and routing to the enterprise are explored and the mapping of enterprise goals to specific PCC rules is proposed. In [23], establishing an eBC Function platform is proposed, with its request analysis, call flows, connectivity and context data management. An additional eBC enterprise application is in [24], for selecting access network (force-on /force-off) for its employees. Another prospect for eBC usage is in establishing ad-hoc collaborations with appropriate security, similar to [13], but using eBC to base it on session context rather than tagged data.

The eBC Model is intended to interwork with mobile broadband networks, interfacing to PCC (Policy and Charging Control), as specified in 3GPP [1] and [11]. Few researchers address funding aspects of mobile data but many have written on granting access to IT /web data, which is relevant to the eBC service authorization. Most IT studies propose a form of RBAC (Role Based Access Control) as in [4], or its variants, such as Temporal RBAC in [7]. Less popular is Task Based Access Control (TBAC), which is considered for limiting permissions validity to the task duration, as in [5]. However, this task definition (a single IT workflow activity) is not the same as the eBC Task Template, which is designed as a profile of the user's activity context.

Using ABAC (Attribute Based Access Control) for access permissions, as argued in [14] and [15], is well established. In [9], XACML based ABAC for Health records has proven very efficient. ABAC uses attribute details to prove users' 'claims', e.g. a birthday record to prove that the user is over 18. Using attributes for web services is favored over roles because the Internet is said to be 'Identity-less' and cannot scale up if it is constraint by a user identity database. However, service authorization for employees must be identity-driven anyway. In the eBC Model, Attributes are information items that describe the session request and the current user scenario. As such, attributes can be derived from several sources, which may lead to conflicts. In [18], an algorithm to resolve ABAC conflicts is proposed, which could be added to the eBC logic. In [2], learning methods from 'fuzzy' context is proposed in order to overcome inherent context appreciation errors. Similarly, we propose to 'learn' from historical data of the granted and not granted eBC status per scenario.

The separation of context assessment from policy rules, which is seen as an advantage in [12], is implemented in our standalone eBC Model, enhancing its versatility for other purposes. The eBC Model uses a hierarchical hybrid of roles and rules that has now become the norm in many papers. In [16], data access for mobile broadband is determined from Device, User and Environment sources of context that are evaluated in their PRISSMA module. Similar to eBC, the 'Environment' contains spatial, temporal, activity and 'things'. For eBC, these environmental aspects are extended further, to consider mobility, media types, destinations etc.

Not every policy can be translated into prioritization. Some policies require conditional, semantic based processing. In [3], the DySCon architecture contains similar components (roles, tasks, locations, activities), and processing logic (not algorithm) is used to select which policy to apply. While additional logic is used in the eBC Function for adjusting credit/budget policies, we believe that the eBC Model algorithm is suitable for processing dynamic factors.

Prioritization decision-making techniques have been studied in many non-Telecom disciplines. Similarly, multi-layered prioritization is used for injecting enterprise objectives into the eBC Model. This multi-level structure is based on AHP (Analytic Hierarchy Process), as described in [19]. The values are computed by a method that can be described as SAW (Simple Additive Weighting). The prioritization is applied to 'normalized' values that are derived from context attributes, using the MADM (Multi Attribute Decision Making) model, which employs fuzzy logic to achieve deterministic attribute values. Numerous papers describe these methods, but a useful comparison is given in [20].

In the rest of the paper, Part II introduces the eBC Model structure and describes the eBC elements. Part III explains the computation and the prioritization algorithms. Part IV describes how the model is constructed, populated and used, with its built-in representative scenarios and threshold calculation. Part V contains conclusions.

II. THE EBC MODEL ELEMENTS

A. *The eBC Model Structure*

The eBC Model is built of Roles, Tasks, Factors and Attributes. Roles provide user's privileges according to job descriptions. Tasks Templates capture corporate typical practices tasks. Factors describe session aspects and Attributes define the session metrics from context data items. The assigned priority ratios are applied to the eBC elements to produce an overall Task score. The computed scores for all the Task Templates are compared and the highest value becomes the Prevailing Task. This Task has an associated pre-defined PCC rule. Figure 2 shows the eBC Model structure. Attached to each component are the weighting ratios. The same Attributes or Factors have different prioritization (color-coded) in each Task Template.

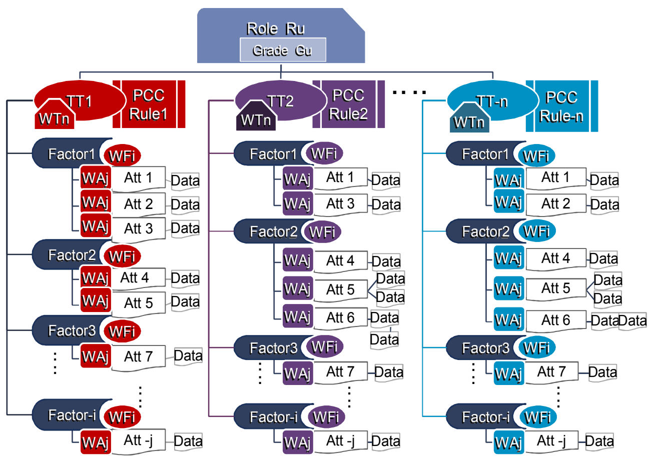

Figure 2. The eBC Model structure

B. *eBC Task Templates*

Each Tasks Template (TT) represents a context scenario for a particular business practice. Using templates simplifies sifting through sources of context information. Tasks share many common Factors. Some Factors may not appear in all Tasks or may be unique to a particular Task, e.g. only the 'Abroad' Task needs to be aware of roaming aspects. Templates are efficient in their handling and save on redundant processing, since only Tasks that are valid for the Role are processed, e.g. roles that do not involve travel, do not contain 'Travel' or 'Abroad' Tasks. Templates with greater variance of Factor weighting ensure good delineation of Task scores, while similar values make Tasks indistinguishable. Increasing the number of templates unduly may blur their differentiation, making decisions less clear-cut. Several commonplace standard templates have been designed for the eBC Model simulation:

TT1	Routine	Normal place of work
TT2	Home working	Over-time, flexi time, part-time
TT3	Travel	Away from normal place of work
TT4	Essential Task	Urgent, mission-critical engagement
TT5	Abroad	Country/regional aspects, roaming

C. eBC Factors and their prioritization

We propose adding a Factor layer to the model as a means of aggregating attributes into recognizable aspects that make sense to non-telecom administrators. The Factors are aspects that characterize the Task 'environment'. For the eBC Model, we define a set of dynamic Factors (STANDS) that are generally needed for context evaluation of service requests:

		The STANDS Factors
S	Spatial	Physical positioning that can be linked to special places, e.g. home, enterprise site, regularly visited
T	Temporal	Time analyzed against working-hours, overtime, flexi time or public holidays
A	Activity	User's engagement such as training, business trip, sickness leave, in-meeting, driving
N	Network Type	Policies for mobile access, home broadband, internal enterprise network or ad-hoc hotspots
D	Destination	Definition of the target addressee, i.e. a person, multi-party, team member, website or application
S	Service Type	Media type, file transfer, video streaming, video conferencing

Factor weighting ratios are set proportionally within each Task Template. They reflect priorities for network utilization for the particular Task. The Factor weighting rate is applied to the Attributes value. The sum of all these weighted Factors constitutes the score for the Task. A prioritized Factor can be prominent in some tasks but not in others, e.g. the Activity Factor has to be particularly high in TT4 (Essential). Naturally, the Spatial Factor is high in both TT3 (Travel) and in TT5 (Abroad). The Temporal Factor is more pronounced in TT2 (Home working) than in TT1 (Routine), to distinguish clearly between personal time and home working.

D. eBC Attributes

In the eBC Model, Attributes are the building blocks of the session context. Attributes define one detail at a time, directly from sources, such as requested destination or work-schedule activity. Attribute values are evaluated in the eBC Function and are provided as input to the eBC Model. Attributes values are true or false, but can be levels of probabilities, e.g. the user is now 'near' work (true but only 75%) or the destination is an approved application (true 100%). Attributes are mutually exclusive, i.e. when several sources provide data for the same context element, the highest probability Attribute prevails. For example, the Network Type Factor can have only one network type, but the highest probability location (from GPS or WiFi) is taken for the Spatial Factor. Attributes weighting is used to reflect the desirability of an Attribute within the Task, e.g. less resource-intensive media is preferable.

III. THE COMPUTATIONAL EBC MODEL

The eBC Model calculates nested priorities to produce the eBC score and identify the prevailing Task Template (TT) and its PCC rule:

The Role (Ru) determines the templates (m) that are allowed. Each allowed Task Template (TTn) has a priority (WTn) within the Role. The Task contains Factors (Fi) which are weighted by a configurable ratio (WFin) within the TT. Factors contain Attributes (Aj) with assigned weighting ratios (WAjn) within the TT.

Tasks

TTn is Task in $TT=\{TT1,TT2...TTm\}$ if $1 \le n \le m$ (1)

TTn is a permissible Task that is contained in Ru Role:

$TTn \in TT$ and $TTn \in Ru$ (2)

Tasks are weighted by WT entered prioritization.

Highest TTn score determines the prevailing Task (TTu)

$TTu = \max \{(TT1 \cdot WT1), ...,(TTm \cdot WTm)\}$ (3)

It is modified by Grade Gu: $eBCscore = Gu \cdot TTu$ (4)

Factors

Fi is a Factor where $1 \le i \le f$ within TTn

Fi contains the prevailing weighted Attribute

Fi is weighted by the assigned WFi within the TTn

$WFin \in WF$ when $WF = \{WF1n, WF2n...WFfn\}$ (5)

Where $0 \le WFin \le 100$ and $\sum WFin = 100$ (6)

Weightings are proportional within TTn. For ease-of-use, entered ratios InputWFin are converted to proportional weightings: $WFin = 10 \cdot InputWFin / \sum inputWFin$ (7)

Fi in TTn is weighted by $Fin \cdot WFin$,

TTn is the sum of the weighted Factors:

$TTn = \sum Fin \cdot WFin$ (8)

Attributes

Attribute Aj is a set element within Fi within TTn

$Aj \in Fi$ and $Fi \in TTn$ where $1 \le j \le a$ (9)

The Aj 'normalized' value range is: $1 \le Aj \le 10$

Aj has weighting WAjn within TTn,

$WAn = \{WA1j, WA2j...WAjn\}$ (11)

Where $0 \le WAjn \le 100$ and $\sum WAjn = 100$ (12)

For ease-of-use, entered weighting ratios InputWAjn are converted to proportional weighting ratios:

$WAjn = 10 \cdot InputWAjn / \sum inputWAjn$ (13)

The value of Fin is the highest Attribute:

$Fin = \max\{A1j \cdot WA1j, A2j \cdot WA2j... Ajn \cdot WAjn\}$ (14)

Accuracy of eBC-based decisions is dependent on fine-tuning of the assigned weighting ratios. Therefore, much is due to the values entered by the enterprise staff. Utilizing the eBC historical log can improve their accuracy and indicate frequently occurring scenarios that should be added.

IV. BUILDING THE EBC MODEL

A. Building Templates and Factors

The eBC Model components and their weighting ratios are fully customizable. Figure 3 shows an input screen to create and modify Tasks, Factors and Attributes and their respective weighting ratios. Displayed Attributes must be already linked to sources of context data that are accessible in real time. Where necessary, some Attribute data can be cached periodically, to avoid pressure on IT systems that were not designed for real-time access.

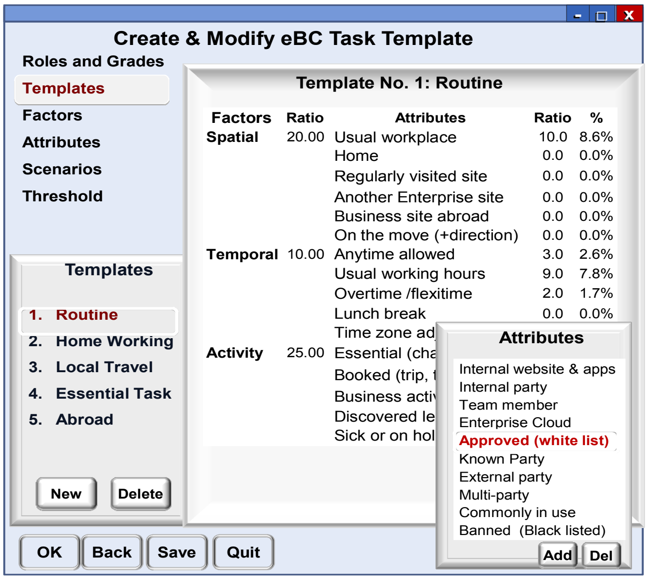

Figure 3. Creating Templates and Priorities

Special enterprise objectives can be reflected in prioritization that influences employee behavior, e.g. what type of media is used, when and where and during what Task. To encourage team working, a 'Team-member' Attribute can be created in the Factor 'Destination' and given higher priority than other destinations. These behavioral effects can be accomplished merely through customizing weighting ratios. The enterprise staff need not understand how 3GPP policy rules are mapped to their business rules, but merely define priorities for the eBC components. Enterprise staff can experiment with the model and observe the impact of changing prioritization instantaneously.

B. Representative Scenarios

Simulating scenarios by furnishing assumed Attribute values is an integral part of the eBC Model. The scenarios depict combinations of activities and circumstances, such as reading emails at home or contacting a colleague on the way to the office. Positive scenarios are configured to represent cases where eBC status should be granted and negative ones when eBC status should not be granted. Scenarios can be created to demonstrate a certain policy e.g. to inhibit video games during work hours. As many as possible scenarios should be built for greater accuracy. Figure 4 shows results from the eBC Model simulation. The threshold line indicates which Task Template is selected.

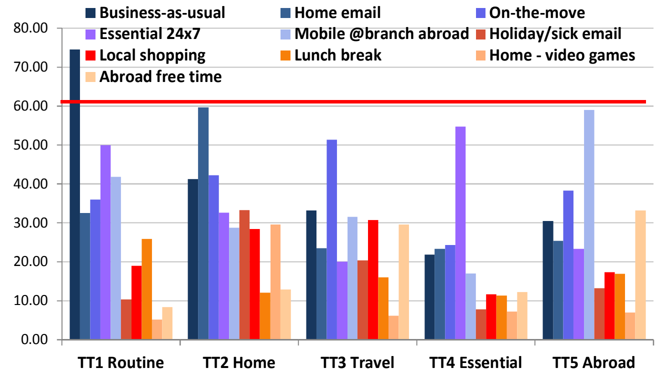

Figure 4. Scenario Thresholds per Task

C. Setting up eBC Thresholds

The threshold for granting eBC is entirely at the discretion of the enterprise. Raising or lowering thresholds has direct impact on how much is enterprise-funded. In some cases, more than one Task exceeds the threshold, so the highest scoring Task prevails. The threshold determination is as follows:

TH:=threshold, TT:= {TT1, TT3...TTm} for m Tasks
TTu is highest scoring Task and final score:=eBCscore

$$eBCscore = \max TTm \text{ and } TTu > TH \quad (15)$$

The results for the representative scenarios are used to determine the optimal threshold. The eBC historical log can be analyzed and depending on budgets - the threshold may be raised or lowered. For greater accuracy, thresholds can be assigned to each Task Template. The individual Task threshold is derived from scores of representative scenarios for that Task. To select the 'prevailing' Task Template, the margins of each Task score exceeding the Task threshold need to be compared.

Threshold THn exists per Task TTn, for (m) evaluated Tasks. Threshold Margin:=THMn

$$TH=\{TH1,TH2,...THm\}$$

$$THMn = TTn - THn \quad \text{if} \quad THn < TTn \quad (16)$$

eBCscore=TTu if

$$THMu=\max\{THM1,THM2,..\ THMm\} \quad (17)$$

V. CONCLUSIONS

In this paper we present an eBC (enterprise Business Context) Model that distinguishes between 'business' and 'personal' usage for funding decisions. By using the eBC status, the enterprise can realize cost savings from BYOD, manage resource allocation, curb employee personal usage and automatically reimburse business expenses.

The eBC Model has several challenges, not least accuracy and flexibility, but above all - ease of customization by non-telecom personnel. We built a simulation of the eBC Model to test the balancing of the layered prioritizations. Creating representative scenarios provides the base line for positive cases where eBC status should be granted and negative cases where eBC status is not granted. The eBC Model has been proven to be robust and stable, and we believe - viable.

References

[1] 3GPP TS 23.203 Policy and charging control architecture Release11

[2] Yu Zhang, Fanzhang Li “A Model of Context Awareness Agent System based on Dynamic Fuzzy Logic”

[3] Ahmad Kamran Malik, Hong-Linh Truong, Schahram Dustdar “DySCon: Dynamic Sharing Control for Distributed Team Collaboration in Networked EnterprisesTeam Collaboration in Networked Enterprises” IEEE 2009

[4] D Ferraiolo, D Kuhn “Role-Based Access Controls” 15th National Computer Security Conference (1992) Baltimore

[5] R Thomas, R Sandhu “Task-based Authorization Controls (TBAC): A Family of Models for Active and Enterprise-oriented Authorization Management” IFIP 1997

[6] S Ahmad, R Ahmad “Design of Algorithm for Environment based Dynamic Access Control Model for Database Systems” International Journal of Computer Applications May 2011

[7] R Bhatti, E Bertino, A Ghafoor “A Trust-Based Context-Aware Access Control Model for Web-Services” Springer 2005

[8] Ahmad Kamran Malik, S Dustdar “A Hybrid Sharing Control Model for Context Sharing and Privacy in Collaborative Systems” IEEE 2011

[9] S Sucurovica,V Milutinovic “The Need for the Use of XACML Access Control Policy in a Distributed EHR”

[10] A C O’Connor, R J Loomis “2010 Economic Analysis of Role-Based Access Control” NIST, Gaithersburg, MD 20899, December 2010

[11] 3GPP TS 29.214 Policy and Charging Control over Rx Release11

[12] A Dersingh, R Liscano, A Jost “Context-aware access control using semantic policies” Ubiquitous Computing and Communication Journal , UBICC 2008

[13] P Kodeswaran, S B Kodeswaran, A Joshi, T Finin “Enforcing security in semantics driven policy based networks” Computer Standards & Interfaces 33 (2011)

[14] G Bayer, D Sengupta, T Wang, A Vogt “PrplAc: Attribute-based Access Control in PRPL for Fine Grained Information Sharing using Semantic Web” Stanford University, 2008

[15] M A Al-Kahtani, R Sandhu “Induced Role Hierarchies with Attribute-Based RBAC” Sacmat 2003

[16] L Costabello, S Villata, N Delaforge, F Gandon “Linked Data Access Goes Mobile: Context-Aware Authorization for Graph Stores” LDOW2012 April 16, 2012

[17] L Cirio1, I F Cruz1, R Tamassia “A Role and Attribute Based Access Control System Using Semantic Web Technologies” 2007 OTM Confederated international conference

[18] Cheng-chun Shu, E Y Yang, A E Arenas “Detecting Conflicts in ABAC Policies with Rule-reduction and Binary-search Techniques”2009 IEEE

[19] M Lahby, C Leghris, A Adib “A hybrid Approach for Network Selection in Heterogeneous Multi-Access Environments” 2011 IEEE

[20] K.Savitha, Dr.C.Chandrasekar “Vertical Handover decision schemes using SAW and WPM for Network selection in Heterogeneous Wireless Networks” GJCST (2011)

[21] R Copeland, N Crespi “Analyzing consumerization - should enterprise Business Context determine session policy decisions?” in press, IEEE ICIN 2012

[22] [17]R Copeland, N Crespi “Controlling enterprise context-based session policy and mapping it to mobile broadband policy rules” in press, IEEE ICIN 2012

[23] [18]R Copeland, N Crespi “Establishing enterprise Business Context (eBC) for service policy decision in mobile broadband networks” ICCCN ContextQoS 2012

[24] [19]R Copeland, N Crespi “Selecting Access Network for BYOD enterprises with Business Context (eBC) and enterprise-centric ANDSF” in press Springer, Mobilware 2012