Controlling Enterprise Context-Based Session Policy and Mapping It to Mobile Broadband Policy Rules

Rebecca Copeland
Core Viewpoint Limited, United Kingdom

Noel Crespi
Institut Mines-Telecom, Telecom SudParis, Evry, France

Abstract— In this paper we propose a method of translating enterprise business objectives into service delivery policy rules in Mobile Broadband networks. This enables enterprises to control their own session policies for BYOD (Bring Your Own Device) users and apply selective funding with prioritized service delivery. The proposed eBC (enterprise Business Context) Policy process uses internal corporate data to define session context attributes, which are evaluated against business policies to produce an eBC profile. This is used first to grant funding or defer the request to the user's carrier as 'personal use'. Funded requests are processed further to determine service authorization levels and session delivery profiles. Finally, these values are mapped to 3GPP PCC parameters. We examine the feasibility of enterprises controlling and conveying session policies in terms of routing and intercepting employees' requests, and in conveying policy information to carriers using standard interfaces and accepted 3GPP models, such as Sponsoring Data and Virtual Networks.

Keywords-Consumerization, Context, BYOD, Context, QoS, PCRF, Policy, Sponsor, VNO, ADC, DPI, SLA,

I. INTRODUCTION

A. Consumerisation trends

The fast growing trend of consumerization or BYOD (Bring Your Own Device) is now well established in North America and Europe, and is growing relentlessly in enterprises around the globe. This means that employees can use their own smartphones and tablets in the workplace, for Internet access and internal business applications. Figure 1 provides a snapshot in March 2012, showing that already 23% of employees are using *only* personal devices for work in the USA, 23% are using only corporate devices, but most (54%) are using both.

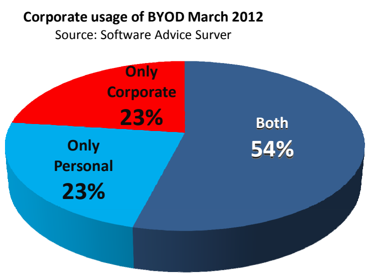

Figure 1: Enterprises embracing BYOD

The growth of consumerization has been very fast, and is still accelerating. Enterprises are pleased to see IT cost dropping. Employees are happy having a choice of latest technology and are willing to work longer at their convenient locations. However, this unstoppable trend will result in far reaching changes. The rising consumerization practice has a double-edge sword effect: the smart devices market grows while the enterprise market shrinks, with each enterprise bringing fewer subscribing employees. Mobile carriers now need to entice each employee individually. Ultimately, the enterprise market may disappear as corporate mobile contracts are not needed if all employees are consumers.

B. Greater need for Enterprise policies

Enterprises need to adjust to BYOD. They are already building up their device-support and security strategies. They also must find ways of reimbursing employees' business expenses. Some companies pay employees' usage costs as an allowance, while many rely on detailed expense claims. As neither of these methods is satisfactory, BYOD requires distinguishing between employee's business usage and personal usage. This can be achieved by evaluating the 'enterprise Business Context' (eBC) for every session, to determine how they should be treated, i.e. provide selective funding, where business usage is paid directly by the enterprise, but personal use is funded by the personal subscriber account with the carrier.

Excessive consumption of personal content is one of the main risks of BYOD. Allowing personal use with smart devices can ramp up usage costs fast. Enhanced productivity may somewhat compensate for it, but indiscriminate consumptions, especially when roaming, can be prohibitively expensive. This needs more than pay-or-reject decision, but a considered decision of levels of authorization and session priorities according to circumstances.

Business rules cannot be consistently applied by all carriers that may be chosen by employees. The enterprise is the common factor that can establish consistent policy for all situations. In [11] the issue of applying business goals to network management while maintaining 'policy continuum' is raised. Such a policy continuum is also needed for BYOD.

C. Related Work

In this paper a technique of assessing context-based session policies is proposed and a method of mapping them to 3GPP policy rules. This paper builds on the concept introduced in [16] to allow enterprises, not carriers, decide on session delivery parameters, based on business context that supports BYOD. In [17], a function that establishes Business Context, with its platform, logic, call flows and inter-connections is proposed. In [18], a practical, customizable eBC Model and representative scenarios are described, showing results from the Proof-of-Concept.

There is a large body of research into IT based access control, addressing service authorization by means of RBAC (Role Based Access Control), TBAC (Task Based Access Control) and ABAC (Attribute Based Access Control). Few studies refer to mobile networks. Those that do, consider mobility context rather than integration with 3GPP mobile networks. The concept of user-centric policies composed from operational QoS (Quality of Service) policies and business QoS policies has been discussed in [2], but its focus is 'unifying' repositories when the user has two identities. For BYOD the reverse is needed, i.e. differentiating between policies for a single ID. Mapping business goals to data network policies has been proposed in [4], [11] and [12], using various mechanisms of web ontology and semantics. However, bridging the gap between IT and Telecom does not lend itself to semantics, especially where the enterprise terminology is so different. This requires an alternative approach.

D. *The Paper Contents*

The remaining paper is structured as follows: Part II proposes a method of transforming business goals and context data into an eBC session profile. Part III explains the proposed mapping of the eBC scores to PCC (Policy and Charging Control) rules. Part IV examines inter-entity models for conveying enterprise policies in 3GPP networks. Part V explores how to intercept employees' service requests and relay triggering events. In Part VI - conclusions.

II. TRANSFORMING BUSINESS GOALS TO SESSION POLICIES

A. *Enterprise Policies versus Network Policies*

To enable decision making for session delivery, the enterprise business objectives should be mapped to network rules and enforced by the carriers. As shown in Figure 2, context and policies for the enterprise are quite different from those of the carriers'.

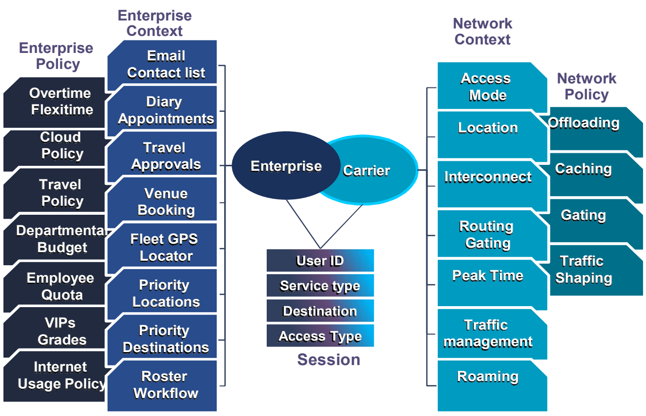

Figure 2: Compare context and policies

The common area is the session details, such as service type, destination or media type, which are used in both cases to determine context. Using these details, existing Telco policy servers can provide some context-based variations, but they do not go far enough to implement more complex business rules per session.

The enterprise needs greater flexibility than provided by carriers. Enterprise policies are concerned with business decisions to support travel, critical tasks, overtime policies or departmental budgets. These policies define what is funded, at what level of funding and what service priority is given to particular tasks within a particular context. They determine not only session priority, but also desirability for the business. This needs to be translated to the policy rules that are defined in the PCC architecture. If these business considerations can be expressed as a scale of importance and desirability, this scale can be used to modify typical session settings in the PCC rules.

B. *Methods on mapping policies*

There are already many suggestions of ways to translate business policies into computed actions, based on a semantic approach. In [4], automated context-aware policy for self-adaptation of software using web ontology is proposed. Interpreting human descriptions of policies into executable rules is suggested in [11]. Partly automated solution for translating different types of policies into 'low level web service policies' is proposed in [12], which also addresses the issue of collating policies from different entities.

Although some of these solutions are generalized, they do not resolve BYOD challenges and cannot map to Telecom PCC rules. They rely on readily available policy repositories that do not exist and on coherent terminology that is lacking between IT and Telecom. Enterprises are unlikely to have an actionable list of policies that can match network policy decisions. Such policies are, for example, what context is accepted for business, what tasks are relevant to a role, what service types (e.g. video streaming) is permitted from which location etc.

We believe that an experimental approach may be best to bridge the gap between enterprise policies and the required output of mobile session parameters. Since there are no ready business policy lists to use, such policies are created by injecting business-based prioritization in a customizable model that describes business tasks and their components. These priorities are maintained by enterprise people with no Telecom skills, who can learn from their experience how to align session funding decisions with network delivery parameters.

C. *The proposed business context evaluation*

The proposed enterprise Business Context (eBC) Policy contains a function that assesses business priorities using context data. Its structure, processing logic and links to context data are described in [17]. The context elements are arranged in a hierarchy of elements including Attributes, Factors, Tasks and Roles. This integrates the notions of RBAC, TBAC and ABAC in a hybrid model, with the addition of Factors that group context information into meaningful session aspects.

The eBC Function contains a computational eBC Model, which is described in [18]. This model allows employees to design Task Templates, which contain a choice of contributing

Factors and Attributes. These context elements are assigned configurable priorities that characterize the Task.

Roles, as in many RBAC solutions, contain grades, quotas and privileges that are set by the enterprise administration. Roles define the list of permitted Tasks. Tasks represent current user engagement and circumstances, such as working at home, routine office work or local travelling. Combinations of Roles and Tasks reflect common practices, e.g. Travel Task is important to Sales Role but not to desk-bound Administrator. Therefore, Tasks have a scale of importance within each Role, for example, the Routine Task may have lower priority than Essential Activity.

Factors, such as Location, Destination or Activity, characterize the Task by their levels of priority. The Factors facilitate Attribute aggregation, collating together various sources of context data. Attributes are the atomic context data items, expressed as 1/0 (true/false) or probability values in between. Like Factors, Attributes are weighted within the Task.

Figure 3 shows the structure of the eBC model. Processing starts from the employee's Role, which indicates what tasks (1) need to be evaluated. The Task defines the Factors to be examined (2). The Factors contain specific Attributes (3). The Attributes are retrieved and aggregated for their Factors (4). These Factors and Attributes are weighted within each Task Template to provide a characteristic Task numeric eBC Profile that identifies the prevailing task in each scenario and is used to map to the PCC Rules (5). When a session scenario is assessed from its Attributes, the computed scores for the Task Templates are compared against a configured threshold. If a Task exceeds the threshold, the session is granted an eBC status.

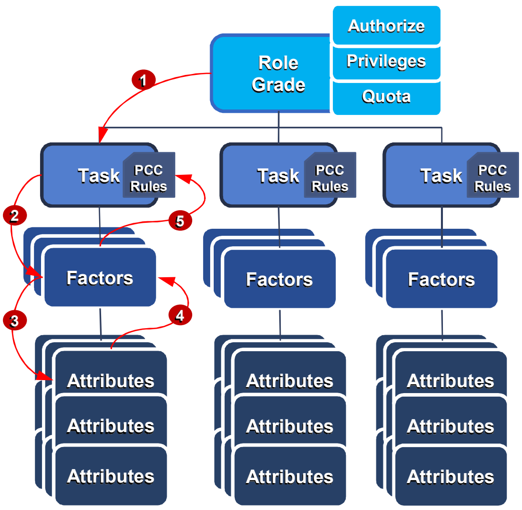

Figure 3: Linking policies with PCC rules

By experimenting with scenarios, enterprise staff can learn what task templates should be created to fit their particular enterprise business and how to prioritize role grades, tasks, factors and attributes. They can also gauge at what levels the thresholds should be set, in order to increase or decrease the number of sessions that are granted funding. See examples of worked scenarios in [18].

III. Mapping to 3GPP based PCC Rules

A. *The scope for mapping parameters*

For the enterprise policies to be enforced, they need to be conveyed to the carriers in the standard formats for mobile networks, complying with 3GPP Policy architecture, as specified in [1]. The PCC Rule includes informative details as well as scalar parameters. The informative details identify the route, the parties, the media and the charging modes, while scalar variables define levels of service QoS and priority.

An important informative detail for the enterprise policy is the Sponsoring ID, identifying the enterprise network server, when the Sponsor model is used (see below). The Charging Key points to the carrier's OCS (Online Charging System) to enforce credit limits that are set by the enterprise. A subset of items specified in the PCC Rules and a list of optional triggers are shown in Figure 4, highlighting (in blue) parameters that can be modified according to the context evaluation.

Standard PCC Rules 3GPP TS 23.203	PCC Triggering & Monitoring 3GPP TS 23.203
PCC Rule identifier	Usage report required
Service data flow Precedence	QoS change exceeding authorization
Service data flow template	Routing Area ID change
Charging Key	User location change
Service identifier	UE time zone change
Sponsor Identifier	Access change
Application Service Provider	Application start/stop
Service identifier level reporting	Routing rule change
Gate status	Reallocation of credit
QoS class identifier QCI	User CSG information change
UL/DL Max Bit Rate (MBR)	Revalidation ADC time limit
UL/DL Guaranteed Bit Rate (GBR)	Authorized QoS per bearer (UE)
Allocation /Retention Priority (APR)	Authorized MBR per QCI (network)
Authorized UE-initiated QoS per bearer	Monitoring key for shared usage
Authorized network-initiated MBR per QCI	Volume threshold to be reported
Revalidation time limit	Monitoring Time to reapply threshold
ADC Revalidation time limit	

Figure 4: PCC Rules & Triggers list

B. *Using eBC to modify PCC parameters*

Having established that a service request merits a status of Business Context, the enterprise can use the selected Task to gauge what session parameters and levels of funding should be assigned. The Task Template has an associated 3GPP PCC Rule, which is furnished with default values that are pre-configured for the Task. These values are assigned according to the Task characteristics, indicating what uplift should be applied to what scalar variables. Scalar PCC variables are modified according to the eBC analysis by uplifting or reducing the default values of the Task Template. In this way, we propose modifying normal values that are normally set by known algorithms or by general practice (e.g. bandwidth).

Trigger notifications determine which sessions are monitored, what applications are metered and what events cause policy re-evaluation. The PCC Rule contains pre-configured trigger lists to be activated according to the Task characteristics. However, certain atomic Attributes can influence the triggering choice, e.g. monitoring particular untrusted applications or resource-hungry media types.

Each Task Template is rated within the Role, emphasizing the priority given by the enterprise to that task within the Role. Limiting the tasks that are permitted per Role (i.e. zero-rated tasks) is an important tool for the enterprise to distinguish what activities should be funded. Figure 5 shows an example of Tasks rating, including zero-rated tasks that are not permitted for this role.

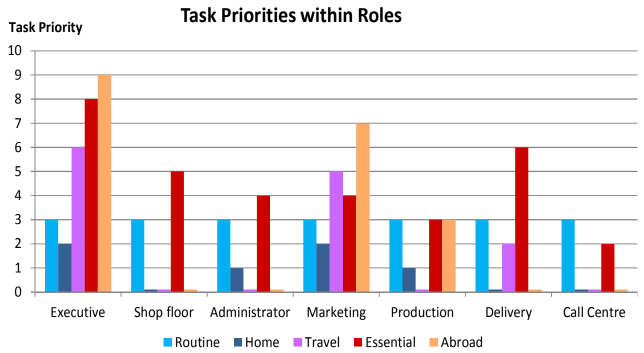

Figure 5: Example of Roles /Grades with Task priorities

C. *The PCC Rule processing*

The output from the eBC Model is processed further to arrive at mapped PCC Rules, as shown in Figure 6. It shows that there are parameters modifiers per Task (TT1, TT2...). The eBC score parameters that are shown above (shaded) are used to modify scalar PCC Rule parameters (white) shown below.

eBC Profile Values	TT1 Routine	TT2 Home	TT3 Travel	TT4 Essential	TT5 Abroad
Threshold Margin	TM1	TM2	TM3	TM4	TM5
Task weights	WT1	WT2	WT3	WT4	WT5
Role Band	RB1	RB2	RB3	RB4	RB5
Dept. Band	DB1	DB2	DB3	DB4	DB5
Charging Uplift	ChU1	ChU2	ChU3	ChU4	ChU5
QoS Uplift	QU1	QU2	QU3	QU4	QU5

Figure 6a: Parameter modifiers from eBC results

PCC Rule Values	TT1 Routine	TT2 Home	TT3 Travel	TT4 Essential	TT5 Abroad
Validate Time	VT1	VT2	VT3	VT4	VT5
APR	APR1	APR2	APR3	APR4	APR5
QCI	QCI1	QCI2	QCI3	QCI4	QCI5
MBR UL	MUL1	MUL2	MUL3	MUL4	MUL5
MBR DL	MDL1	MDL2	MDL3	MDL4	MDL5
GBR UL	GUL1	GUL2	GUL3	GUL4	GUL5
GBR DL	GDL1	GDL2	GDL3	GDL4	GDL5

Figure 6b: Mapping PCC parameters to eBC modifiers

The difference between the Task score and the pre-configured Task threshold constitutes the Threshold Margin (TM). The TM indicates high-medium-low scale to be applied to scalar values. The Task Weighting (WT) is assigned to the Tasks in order to prioritize its importance for the Role. A Role band (RB) is assigned to each Role, to signify their priority to the enterprise business, especially for quota levels, perhaps when allowing overrunning quotas. A Departmental Band (DB) may also be used to prioritize sessions for customer-facing departments, for example. The Charging Uplift (ChU) is modified by the Task uplift according to the TM scale, e.g. a very high margin score for the Essential Activity Task Template could indicate that charging quotas should be waived, while low margin score translates into zero uplift.

For mapping business policies that affect the level of service delivery and QoS, the scalar variables are used. Validate Time (VT) affects triggering a re-evaluation of the policy. It may be used to check more often on Home Working or expensive roaming calls. Another scalar is the APR (Allocation & Retention Priority), which is a useful indicator of the session priority in the network, and should have a higher value for the Essential Task, for example.

The QCI (Quality Class Indicator) is based on the type of service media, e.g. video streaming, browsing file transfer, Voice or real-time Video, but may be set to 'best effort only' for undesirable requests with low scores. Thus, undesirable sessions are not rejected, but are allocated low level of resources. Bandwidth requirements are modified within the normal range, according to the level of importance that is indicated by the eBC score. This may be applied selectively to the Guaranteed Bit Rate (GBR) and the Maximum Bit Rate (MBR), to distinguish between the Uplink from the Downlink bandwidth. For example, the Home Task, downlink (MDL and GDL) may be assigned higher than the uplink (MUL and GUL). Both uplink and downlink are raised for the Essential Task (via the QoS Uplift default value), to ensure good connectivity in critical sessions. 'Validate Time' for 'Abroad' task can be set to a lower level than in the 'Routine' Task, to monitor an expensive connection more closely.

IV. The Enterprise Policy Server in the Network

A. *Proposed Network Integration*

The enterprise can deal with carriers in two modes: as a Sponsor of services for its employees, or as a VNO (Virtual Network Operator) controlling employees' accounts. Figure 7 shows the enterprise policy function interacting to mobile carriers via these alternative methods.

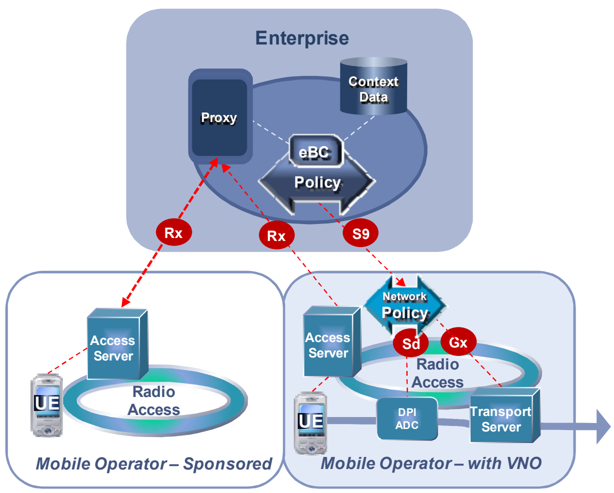

Figure 7: Options of enterprise connectivity

As specified in the call flows in [7], normally requests are routed to the carrier's PCRF (Policy and Charging Rules Function), which produces PCC Rules for the requests, and sends it to the policy enforcement elements. In our solution the enterprise's own policy server generates the PCC rules and relays them to the carrier's PCRF. The eBC Policy server must integrate with mobile networks via standardized interfaces as much as possible. As a VNO, the enterprise acts as another network operator transferring service delivery decisions over the S9 interface. When there is no VNO agreement in place, the standard Rx format is the only option.

B. *Sponsoring Data Services*

The Sponsoring model is specified in Annex N of [1]. This allows the enterprise to act as a 3rd party between content providers and the carrier. The enterprise needs to have a sponsoring SLA with any carrier that employees are allowed to choose. Since there may be many such service providers involved, an automatically negotiated SLA could be useful, as described in [13]. By using the sponsoring mechanism, selective funding can be achieved for specific services. However, for eBC policy, the distinction is not by the service type, but by the session qualifying as business communication. Since carriers cannot distinguish business usage from personal, all service requests need to be diverted to the enterprise to obtain a funding decision. The enterprise will assess the eBC status and reject requests that are deemed as personal.

The service request details are conveyed to the carrier's PCRF using the Diameter protocol AAR command, which includes the 3GPP policy control [19]:

<AA-Request> ::= < Diameter Header: 265, REQ, PXY >
< Session-Id >
{ Auth-Application-Id }
{ Origin-Host }
{ Origin-Realm }
{ Destination-Realm }
[Destination-Host]
[AF-Application-Identifier]
*[Media-Component-Description]
[Service-Info-Status]
[**AF-Charging-Identifier**]
[SIP-Forking-Indication]
*[Specific-Action]
*[Subscription-Id]
*[Supported-Features]
[**Reservation-Priority**]
[Framed-IP-Address]
[Framed-IPv6-Prefix]
[Called-Station-Id]
[Service-URN]
[**Sponsored-Connectivity-Data**]
[MPS-Identifier]
[Rx-Request-Type]
[Origin-State-Id]
*[Proxy-Info]
*[Route-Record]
*[AVP]

The enterprise information as a Sponsor of the service is conveyed in a recently added Diameter extension AVP (Attribute Value Pair) in [19]:

Sponsored-Connectivity-Data::= < AVP Header: 530 >
[Sponsor-Identity]
[Application-Service-Provider-Identity]
[Granted-Service-Unit]
[Used-Service-Unit]
*[AVP]

Using 'Granted-Service-Unit' and 'Used-Service-Unit', the enterprise notifies the carrier how much (volume or money) the user is authorized to consume, i.e. allowing the enterprise to set usage policy.

The Media type is indicated in the AVP code 520, allowing for: Audio (0), Video (1), Data (2), Application (3), Control (4), Text (5), Message (6). The sponsor can ask for session media setting, as shown in the special AVP for media sub-component [19]:

Media-Sub-Component::= < AVP Header: 519 >
{Flow-Number}; Ordinal number of the IP flow
0*2[Flow-Description]; UL and/or DL
[Flow-Status]
[Flow-Usage]
[Max-Requested-Bandwidth-UL]
[Max-Requested-Bandwidth-DL]
[AF-Signalling-Protocol]
*[AVP]

The AF-Signalling-Protocol parameter allows the selection of a protocol between the Carrier's PCRF and the AF (Application Function), which can be anything that negotiates service requests, i.e. a user proxy on behalf of the handset or an application, such as a website service. In fact, this means that policy information can be negotiated outside 3GPP protocols. In [10], XML and SOAP are recommended for the initial exchange of policy information, to ensure platform-independence and ease of programming. XACML (eXtensible Access Control Markup Language) [15] is often used in non-3GPP cases to describe access control policies, but it has no notion of 'session', and can only be used as a single transfer of information in a stateless transaction. Therefore, using the 3GPP S9 [6] interface that gets policy rules installed on the enforcing nodes in the Gx interface [20] is the superior solution.

To summarize, the Sponsor model is designed for service authorization only and does not provide for the full range of session policies to be communicated to carriers. However, where this is the only option, the enterprise eBC Policy can still be used to reformat the Rx message, and insert modified parameters. Only few policy fields are passed through the Rx and there is no ability to request certain triggering and monitoring. Although levels of bandwidth may be requested, there is no facility for the session priority to be set up (to distinguish for requested Reservation Priority). We believe that in support for consumerization, the Rx parameters should be expanded to provide for passing parameters such as guaranteed bit rate (not just maximum), session priority and re-validation time.

C. The enterprise as a VNO

A VNO, when operating its own session control, receives service requests from its users in the same way as a Home Network from roaming users. VNOs vary in what they run in-house or farm out, but owning a policy server is particularly important for them if they wish to differentiate their services. 3GPP facilitates inter-entity policy information exchange over the S9 interface [6], which transfers PCC rules and event notifications in both directions.

While a Sponsor can choose what requests are handled and what requests are not sponsored, the VNO is deemed responsible for all services to its subscribers. While a Sponsor can only request ‘shaping’ the service by asking for maximum bandwidth, the VNO can send complete policy rules. The VNO determines policy rules and forwards them to the carrier, where the final policy decision is made according to resource availability at the target transport network.

Like Mobile VNOs, the enterprise often has its own network (LAN or WAN), now even extended globally with Metro/Global Ethernet. Many large enterprises are also ISP (Internet Service Provider), primarily for their Intranet, and can directly connect users to the Internet from access networks that are under their control. By becoming a VNO, the enterprise is reversing the trend of BYOD. Instead of users utilizing their personal devices for work, the work device becomes a personal one too. However, the choice of the device can still be in the hands of the user, and the choice of a carrier is limited to those with whom the enterprise has VNO relationship.

Another important advantage of the VNO solution is the ability to set up triggers and filtering rules for application control in access networks of the partnering carriers. This is especially significant when funding decision depends on the user activity, i.e. the used application. As described in [20], the ADC (Application Detection & Control) function resides in the policy enforcement layer. Rules are transported from the enterprise eBC policy server over the S9 interface to the PCRF in the delivery network, and transferred to the enforcement node in the Gx interface. For example, the AVP for installing a new ADC Rule is:

ADC-Rule-Install::= < AVP Header: 1092 >
*[ADC-Rule-Definition]
*[ADC-Rule-Name]
*[ADC-Rule-Base-Name]
[Rule-Activation-Time]
[Rule-Deactivation-Time]
*[AVP].

The ADC Rule can define which applications are observed, with reported start and stop times and with modifiable re-validation period. This allows the monitoring to be selective and associated with a particular scenario and, potentially, with a particular eBC status. The ADC Rule can also monitor QoS information and set up which portal to re-direct users when permission levels have been exceeded:

ADC-Rule-Definition ::= < AVP Header: 1094 >
{ ADC-Rule-Name }
[TDF-Application-Identifier]
[Flow-Status]
[QoS-Information]
[Monitoring-Key]
[Redirect-Information]
*[AVP]

V. CONVEYING REQUESTS, POLICIES & EVENTS

A. Service Requests Reaching Enterprise Policy Server

All service requests must be routed to the enterprise and examined by the eBC policy engine to approve or reject enterprise funding. Service requests are routed to the enterprise by means of client configuration, application parameter or service interception. With evolving web technologies, lightweight client widgets can be downloaded to smart devices, as discussed in [14], furnishing personal devices with the enterprise’s server address.

Routing to the enterprise may be easier if the ID contains the enterprise domain, as proposed in [3]. Otherwise, carriers need to identify those user IDs that come under the Sponsor relationship. The scenario that a subscriber may be funded by a Sponsor for some sessions and not others, even with the same content provider, has already been addressed by the standards. However, this is normally based on sponsoring some services but not others. In this case, the enterprise sponsors all types of services for each employee, but certain sessions, i.e. personal sessions, are referred back to the carrier. As a workaround for the Sponsor model, personal-use services can be marked as ‘no-credit’ by the enterprise. However, the carrier should not reject the request but re-process it as for a normal subscriber. This logic needs new call flows that are currently not implemented on commercial platforms.

As a VNO, the issues are reversed. The enterprise will receive all the subscribers’ requests like any carrier, but it needs to re-route back to the carrier those requests that are not recognized as business usage. This could be possible by using number portability techniques, by which requests are selectively re-routed to a new home, having arrived at the enterprise first.

B. Intercepting Detected Applications

Where users establish an Internet connection, the ASP may request service on their behalf. An example of forwarding web requests to 3GPP PCRF is discussed in [9] for Machine-to-Machine services. The ASP may have a sponsoring agreement with the enterprise, in which case the Sponsor ID enables the carrier to re-route to the enterprise. Non-cooperating ASPs sessions must be intercepted by other means. Service request interception is contemplated in [5], for using 3GPP policy and authentication in streaming video services.

Applications are recognized via ADC as defined in [1] and detailed in [20]. Many enterprises are already intercepting unauthorized Internet traffic and may have their own ADC capability. Therefore, if carriers’ ADC information is not provided, an enterprise acting as a VNO can utilize its own facilities. This necessitates that the traffic passes through the enterprise network where the ADC server can analyze it.

In Figure 8, the enterprise deploys the 'Home Routing' method to route the media via the enterprise own ADC server, instead of directly between the parties. However, this increases the load on the network and risks congestion by lengthening the route. To avoid such issues, the eBC Policy can be used to select those sessions that should be monitored via the home-routing option. For example, personal use sessions need no inspection, but funded services that are in roaming mode ('Abroad' Task) or where the media is live Video should be monitored and checked for quota overrun.

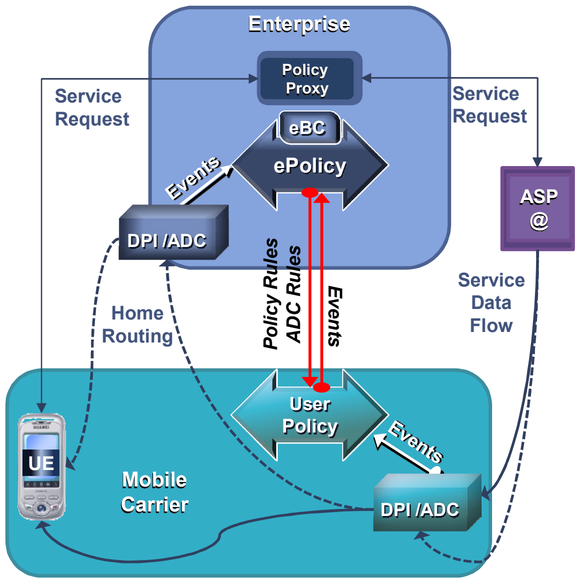

Figure8: Intercepting & event Reporting

C. *Event Reporting and Enterprise Intervention*

Policy is driven by events reported by access and transport networks, as well as the OCS. Policy can dictate whether events notification is required, so that only monitored sessions are reported by the OCS. Cross-entity events' reporting is facilitated under the Roaming/VNO model, but there is no such facility for the sponsoring mechanism. Alerts and triggers are relayed to the enterprise eBC Policy server via the standard S9 interface. Policy and context are re-assessed as a result of reported events and the eBC status evaluated again. OCS events may trigger mid-session re-direction to an enterprise portal, like pre-pay portals, so that employees can request additional funding.

D. *Selecting Alternative Access Network*

The access method is initially chosen by the user or the device. An enterprise policy could force switching to another access network (e.g. LAN instead of 3G), to reduce costs. This possibility has been introduced as Always Best Connected (ABC) in [8]. For an enterprise, the benefits are even greater, as long as there is spare capacity on the LAN and WLAN. We believe that the enterprise could use the ABC facility in both directions. If the eBC status is granted and the session is funded, the enterprise can switch the access mode from mobile broadband to the LAN. If the eBC is not granted, personal use can be switched from the LAN to mobile broadband, which is charged to the user according to the personal quota. This protects the LAN from excessive personal use and also optimizes costs of reimbursed business use.

VI. CONCLUSIONS

Consumerization necessitates that enterprises separate business communication usage from personal usage, in order to apply selective funding and protect enterprise resources. This paper proposes a method of mapping business objectives and corporate strategies to service delivery policy rules in 3GPP mobile networks, using a computed eBC (enterprise Business Context) mechanism to identify the appropriate PCC Rule.

Our method integrates enterprise session policies with 3GPP mobile networks using an experimental approach rather than semantic, whereby enterprise staff can build and maintain the model that computes the session eBC profile, using pre-configured scenarios. This involves a) evaluating prioritized session context to determine whether the session is funded or not; b) transforming prioritized session context into a scalar eBC profile; c) using the eBC profile scales to determine PCC Rule parameters.

This experimental approach is both the strength and the weakness of this method. Success depends heavily on the enterprise handling of the tasks and factors and optimizing their configuration. Accuracy depends on creating appropriate tasks/factors and setting the threshold levels correctly and assigning appropriate user-grades and charging-bands. While the model flexibility is an advantage, it may seem too complicated to first time users. To simplify, certain levels of prioritization can be ignored, e.g. task priorities within roles or departmental charging bands.

To ascertain the eBC profile, we propose a hybrid hierarchical model using roles, tasks, factors and attributes. Roles determine budget bands and permitted Tasks. Tasks contain Factors which aggregate Attributes from atomic context data items. The significance of the Factors and the desirability of the Attributes are injected via the assigned weighting ratios. The model determines the prevailing Task, which has an associated pre-configured PCC Rule that can be refined further, using the eBC profile scalar values.

To receive service requests and convey policies, the enterprise needs to become a VNO or a service Sponsor and support 3GPP standard interfaces. As a VNO, the enterprise can relay PCC rules over the standard inter-carrier interface, S9. For sponsoring, where full policy exchange is not facilitated, we propose that the Rx request format is extended to include further policy parameters.

Mechanisms of intercepting and relaying service requests, charging rules and events between entities are already defined in the standards. However, issues do exist in both VNO and Sponsor models. A VNO receives all requests like a carrier, but lacks the mechanism of deferring non-business sessions back to the personal carriers. A Sponsor can selectively fund services for a user, but lacks the automatic routing of all requests. In both cases, workarounds do exist, e.g. using Number Portability techniques for re-routing and configuring the sponsorship to cover all services.

In summary, an eBC Policy supporting consumerisation is both desirable and feasible. Mapping business goals to PCC standard rules can be accomplished by using the proposed eBC Policy process. Intercepting and re-routing requests and conveying policies from the enterprise to carriers are feasible within the standards, though represent new network scenarios. Using eBC to switch access networks both ways could prove to be a substantial cost saving that justifies the effort of installing the eBC Policy solution.

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