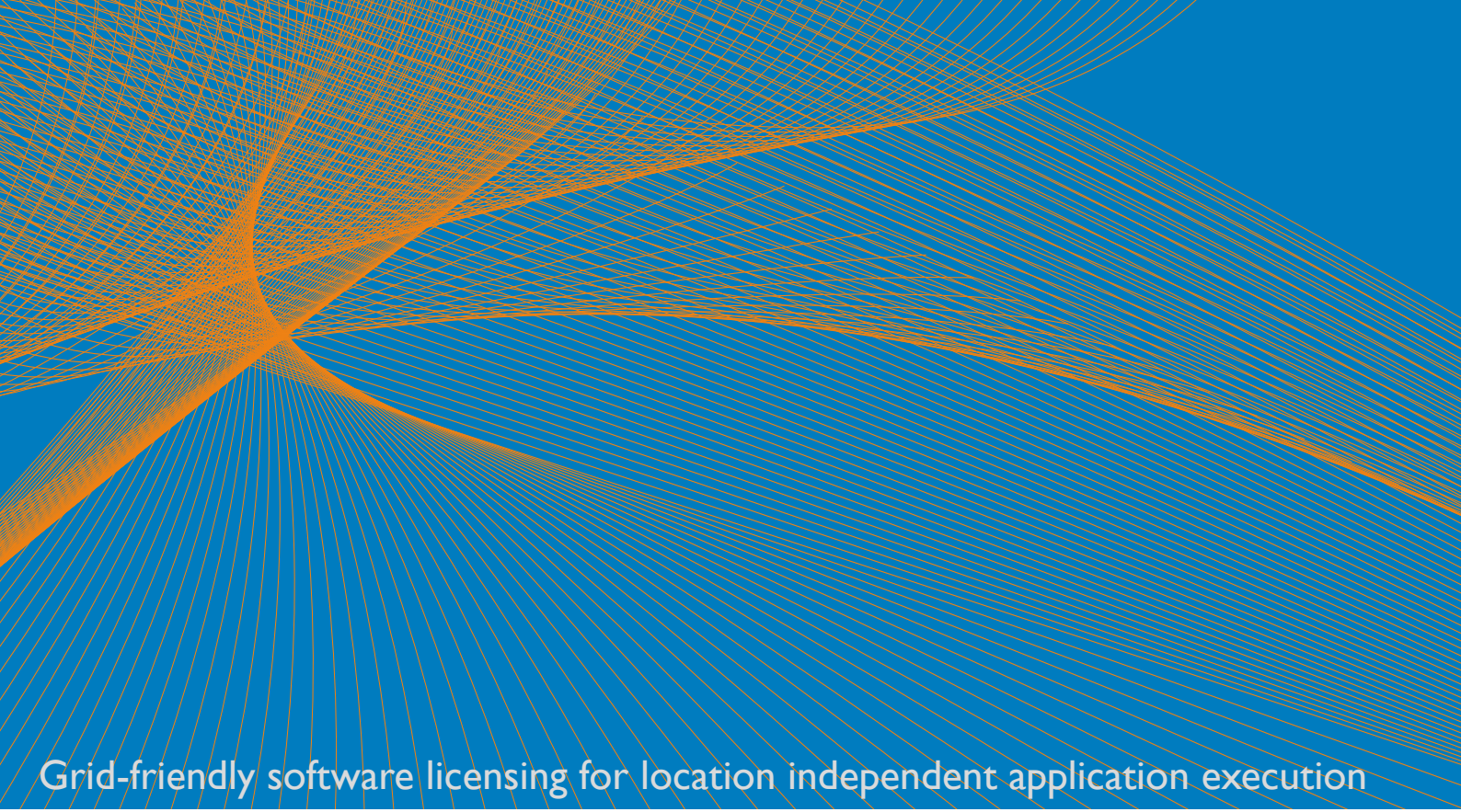

Grid-friendly software licensing for location independent application execution

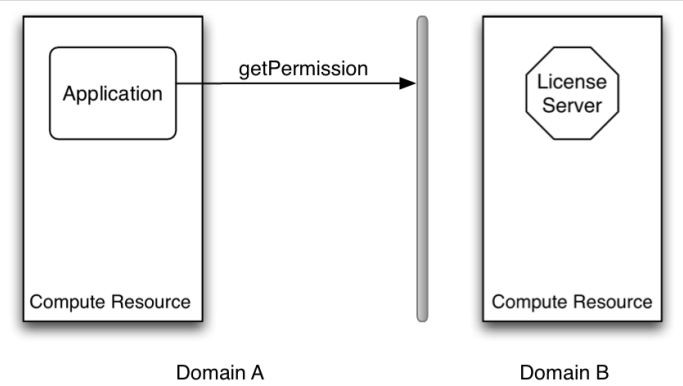
SmartLM

The Problem

IT Infrastructure paradigms have been changing over the last years to support more flexibility and reduce costs at the same time. In parallel, computer-based simulations became more important and tend to become more complex and demanding with respect to the computational requirements. Several approaches to address these issues evolved, driven by academia and industry. Grid computing aims at providing infrastructure for sharing or pooling resources in a collaborative manner. Clouds, which appeared more recently on the scene, focus on resource provisioning, e.g. for peak demand or when customer owned infrastructure is overloaded or its use is not appropriate for any reason.

However, extending a company's business or a research institution's information processing beyond the borders of the respective administrative domain raises a number of issues, one of them is the use of license-protected software. Software protection and licensing are important topics for both the independent software vendors and software users. In Grid and Cloud environments, the use of license-protected applications is almost impossible and becomes a challenging task. The reasons are twofold: (i) there are - with a few exceptions for the Amazon EC2 environment that have been introduced recently - no business models of the independent software vendors for Grids or Clouds and (ii) there is no licensing technology suitable for Grid environments.

Figure 1: Firewall blocking the communication of an application with the license server

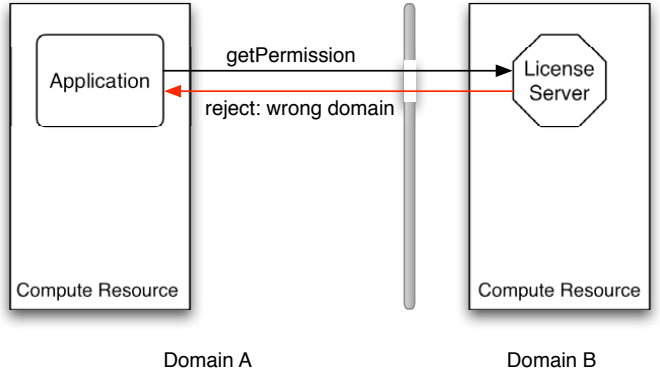


The figures above depict the usual situation: In figure 1 the application is executed in another domain than the license server. Due to the firewall the communication between the application and license server is blocked and the application will be aborted due to the missing authorisation. Figure 2 shows the same situation after the firewall has been opened for the communication between application and license server. However, the license server detects that the request is not coming from an application running in the local domain and rejects the use of the license and the application is aborted again.

Moreover, the current business models of the ISVs most often result in contracts restricting the use of licenses for application execution on resources in a computing centre of the company or institution that bought the license, thus rendering the use of paid licenses for application execution on remote Grid or Cloud resources a breach of contract.

For that reason the 451 group concluded in an extensive survey on licensing issues in Grids that current software licensing practices are limiting the acceleration of Grid adoption already in 2005. Indeed, the rapid emergence of service and virtualization environments requires a rapid evolution in licensing models.

Figure 2: Firewall allowing an application to communicate with the license server



The SmartLM Project

SmartLM aims at rendering mechanisms for managing and using software licenses in a more fair and flexible way. SmartLM licenses may be used seamlessly in local cluster environments, as well as in local or remote Grid and Cloud environments, and under circumstances that the SOA concept presents.

The development of Grid-aware software licensing integrated into service-oriented architectures (SOA) will significantly bolster Grid deployment generally – but specially into new areas exploiting a broad range of commercial software, beyond boundaries of technical and high performance computing.

The ability to effectively and dynamically manage the use of software licenses based on business objectives is not only an issue in Grids, but Grids are an important inflection point in this transformation.
SmartLM is clearly aiming to aid the creation of new industrial opportunities based on the creation of the emerging Service market that uses the service-oriented infrastructure as a means to deliver new software services in great many fields like mechanical industries, Finance, Entertainment, Retail, Pharmaceutics, etc.

SmartLM is contributing to the technology convergence (virtualization, Grid, SOA, etc.) and interoperability with focused contributions to Web Services standards and specifications of the Open Grid Forum (OGF).

The open nature of the new license management software is enabling distributed applications by removing one of the major obstacles for its deployment. Well-known applications can be adapted to this new networked environment, helping organizations to get dynamic access to the right to use applications. This supports not only large enterprises but also Small and Medium Enterprises (SMEs) who do not have the negotiating power to obtain non-standard pricing or licensing from ISVs.

The challenge is to compensate the potential revenue loss on one side with greater business values on the other side. Customer needs and vendor requirements must be balanced.

Software licensing as a No. 1 barrier in commercial grid deployments

Software licensing

Traditionally, software licenses have been provided on the basis of a named user, node-locked host, number of concurrent jobs or possibly a floating site license. These models are not sufficiently flexible to support commercial applications that access resources beyond the current administrative domain – possibly as a Utility-like service outside the organization or Software as a Service (SaaS) model.

Software licensing is identified as a particular concern for enterprise IT managers as they start to deploy virtual Grids in any meaningful way. For all the potential benefits of Grids, IT departments cannot afford to buy software licenses for every device in the service-oriented infrastructure that by nature consumes resources dynamically.

In addition, the Grid-based Service-Oriented Architecture (SOA) solutions together with other technology trends such as multi-core and virtualization environments are forcing Independent Software Vendors (ISV) to move away from traditional software licensing models.

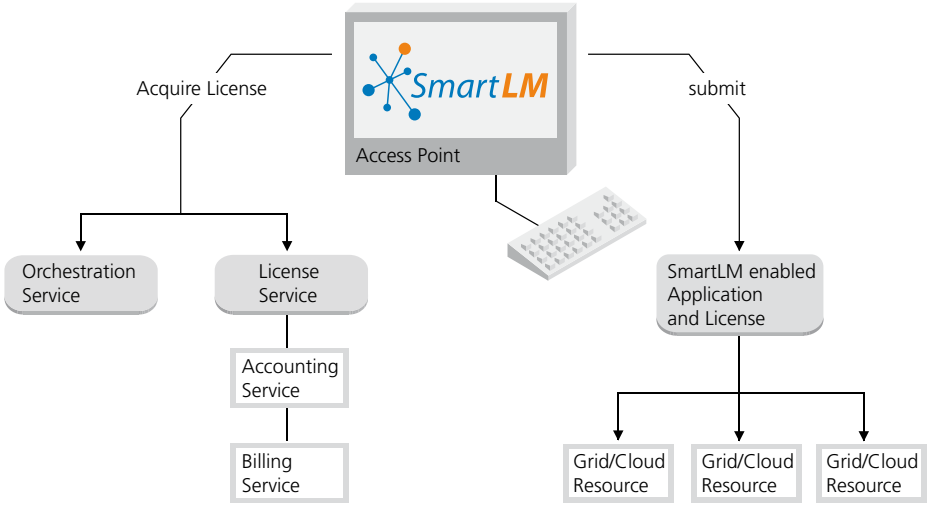
The SmartLM goals

The objective of SmartLM is to provide a new generic licensing virtualization framework based on standards, integrated in major Grid middleware solutions, ready for Cloud environments and Service Oriented Architectures.

The strategic objectives of SmartLM are:

- To understand the licensing requirements for Grid use and deployment in the commercial environment, involving software vendors, application service providers, IT integrators, resource providers as well as end users.
- To identify service-oriented business models for distributed scenarios across organizations.
- To design and build a secure, platform-independent license management framework.
- To provide specific models and technologies for accounting and billing of licenses.
- To enable and validate the license management tools with commercial applications deployed in Grids.

SmartLM´s distributed architecture



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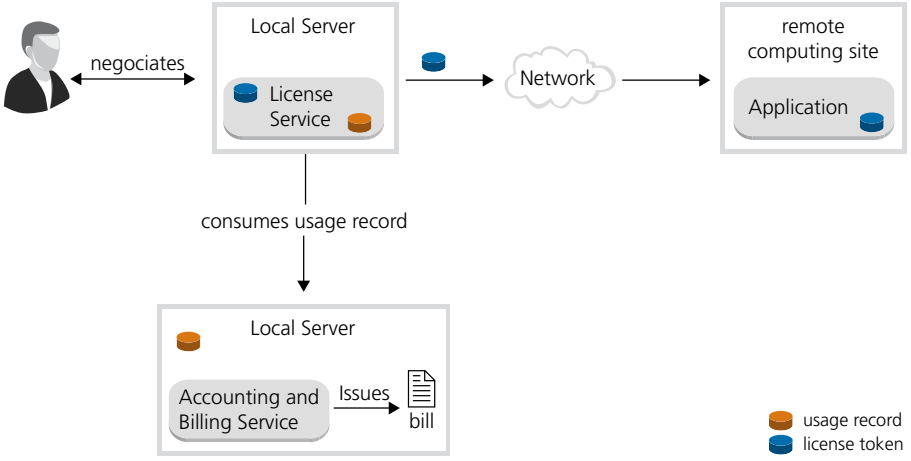
elasticLM – The Product

The overall approach consists in treating and implementing software licenses as Grid services, thus providing platform independent access just like any other virtualized resources.

- Licenses will become Grid services; a promising approach to overcome the limitations of current monolithic licensing models.
- Licenses will be managed as agreements, extending the conventional Service Level Agreements (SLAs) which are made today between sellers and buyers in the market.
- Licenses will be dynamic in order to support agreements that may change over time and where the dynamic negotiation between service provider and consumer is needed.

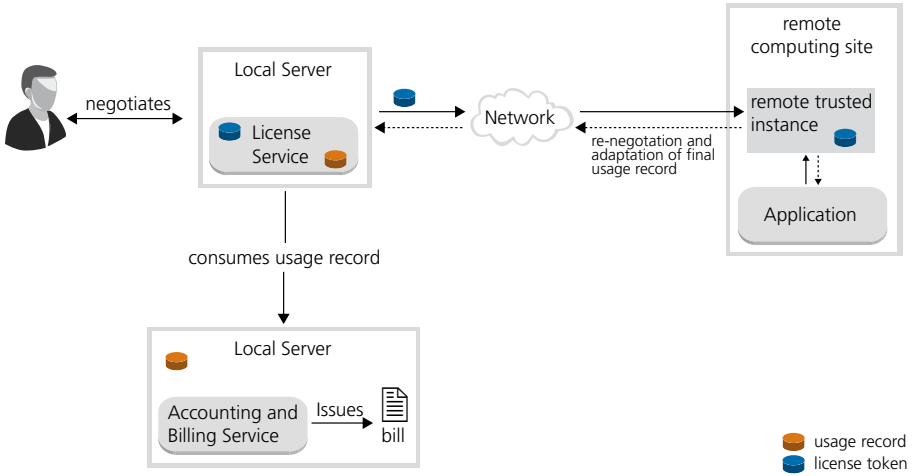
Basic Scenario

No bi-directional network link available at run-time



Advanced Senario

Bi-directional network link available at run-time



elasticLM is implemented as a framework of Web Services. Together with the built-in mechanisms to evaluate different policies prior to taking a decision on the user's license request elasticLM achieves a maximum flexibility. Thus, adapting the functionality and the behaviour of elasticLM to the needs of the respective environments is easy.

elasticLM is based on open standards to ease the integration into existing environments and leveraging interoperability. Moreover, this approach renders the elasticLM system extensible with components adding site-specific functionality, e.g. billing.

In contrast to most of the other existing license management systems, elasticLM comes with an integrated, modular solution for accounting & billing, supporting comprehensive analysis of license usage. Moreover, the integrated approach allows to determine the costs for license usage based on the

users' requests and other parameters like previous usage or department-specific pricing.
Finally, this integration allows checking users' license requests against predefined budgets per user, department etc. License usage is granted only if the request does not lead to a violation of the budget constraints.

Security

Aspects of security have been examined with special care. We identified relevant issues related to both the different actors and the license mechanism itself. These issues relate to

- authentication and authorization of users, services, and servers,
- security and confidentiality of the communication between different actors or components,
- security of the delegation process, when using a portal or an orchestrator, for example,
- disclosure of sensitive information, e.g. compromise of licenses
- integrity of the process to inhibit non-repudiation
- security of the licensing mechanism itself, e.g. the license generators, manipulation of the executables, or clock tweaking

Sophisticated measures have been taken either employing standards like X.509 certificates or XACML and other state-of-the-art technologies for code protection.

Main innovations of elasticLM

elasticLM licenses are mobile objects that may move as applications to different execution environments. Use of protected applications is granted through Service Level Agreements resulting from negotiation of license terms prior to application execution.
Using elasticLM allows advance reservation of licenses. Thus, licenses are available when needed but not blocked when the application is waiting for execution.

All authorization for the use of a license is done locally at the home organisation of a user, taking into account policies of the ISV, site-specific policies defined locally or user-specific attributes as e.g. retrieved from a Virtual Organisation. Signed and encrypted terms of a license are scheduled to the (remote) execution environment.

Integration of an Accounting and Billing System allows price determination and budget control when the license is requested.

Overcoming current limitations by switching to elasticLM

In the following table the major features of the elasticLM product are shown compared to the limitations in current license management:

Current Situation	Innovation of elastictLM
Software licenses allow little flexibility in terms of location independent use. Thus, license protected applications may hardly be used in Grid or Cloud environments.	With elasticLM, licenses may be used to run applications in Grid and Cloud environments no matter whether during the application run there is network connectivity to access the site that hosts the license server that issued the license.
Licenses are often spread across departments making it difficult to track license usage.	elasticLM provides access to and management of all licenses owned by a site.
All license usage policies are embedded in the license of the ISV.	elasticLM allows the definition of local policies for license usage addressing the site-specific needs. These policies are evaluated in addition to the embedded policies of the ISVs.
Before starting an application a user has only limited information about the cost incurred most often estimated based on wall-clock time of usage only.	With elasticLM, an accurate, user-specific price is calculated beforehand based on a large number of configurable parameters, like the time of usage, the features, the history of usage, local policies that define different prices for different users or user groups.
Accounting of license usage more often than not is statically bound to usage times.	elasticLM comes with an advanced accounting and billing system that allows to adapt the accounting information after license usage, taking into account the effective usage, e.g. runtime information, hardware capabilities.

Current Situation	Innovation of elastictLM
License usage control in terms of budget for different users or groups is done independently from the process of granting licenses.	In elasticLM budget limitations are checked and enforced when a user requests a license.
Illegal usage of licenses can be achieved through hacked license servers or hacked versions of the license supplied by the ISV.	elasticLM realises a number of sophisticated, state-of-the-art security mechanisms that render illegal use almost impossible.
License terms are immutable once checked out from the license server.	elasticLM offers re-negotiation of license terms at run-time, e.g. giving up a license before the reservation period is over, trying to extend a reservation period, or adding new features.
License servers only support first come first served schema.	elasticLM allows advance reservation of licences for later use, e.g. coordinated with the availability of computational resources.
Customer owned licenses managed in his administrative domain usually can not be used for running applications using an ASP's computational resources.	Through elasticLM an ASP can temporarily host the customer's licenses allowing the execution of applications using the customer's own licenses. Customers' licences may be combined with ASP owned licenses for running complex jobs, e.g. exceeding the number of processors a single license grants to use, with different applications or application features.

As described in the table above, elasticLM will introduce a number of innovative features compared to existing technology for software licensing. Basically all parties involved can take advantage of using the elasticLM solution:

Independent Software Vendors

Technical characteristics	Benefits
Extended trust management that uses standardized authentication and authorisation technologies.	Providing more flexibility to the trusted customer while increasing the level of security. Easy to deploy in Grid, Cloud and SOA environments.
Capability for defining arbitrary local policies that regulates license usage.	More fine-grained local policies might be defined on top of the policies laid down in the contract between ISV and customer. Thus, ISV policies embedded in the license may be kept simple.
Increased flexibility through token mechanisms for the implementation of new usage models, e.g. pay per use or SaaS.	ISVs may extend their customer base by supporting new business models, thus generating additional economical benefit.

Computing Centres

Technical characteristics	Benefits
Single point for managing licenses.	Better control of the license portfolio in an institution or company. Always up-to-date information on all purchased licenses, e.g. used and free licenses. Thus, less unused or barely used licenses, no duplicate licenses in different departments.
Capability for defining arbitrary local policies that regulate license usage.	Fine grained steering of license usage for all groups and individual users.
License reservation	Licenses are available when needed by an application at a later time. Thus, there is no need to guarantee availability through over-provisioning. This allows the centres to operate more cost-efficiently.
License co-scheduling with resources	Licenses can be used to run applications on the most appropriate or idle resources.

Application Service Providers

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Temporarily including customers' licenses into own pool of licenses	ASP can provide the customer with access to applications without buying additional licenses. Customers' licences may be combined with the ones owned by the ASP for running complex jobs with different applications. This allows making better usage of the ASPs' computational resources while reducing the overhead of maintaining additional licenses for customers.
Capability for defining arbitrary local policies that regulate license usage.	Fine grained steering of license usage for all groups and individual users.
License reservation	Licenses are available when needed by an application at a later time.
License co-scheduling with resources	Licenses can be used to run applications on most appropriate resources, either taking into account the requirements of the customer/the application or the actual situation of the ASP's computational environments, e.g. idle resources.

End users

Technical characteristics	Benefits
Multiple ways to request a license, e.g. portal, Grid scheduler, by the application, a command-line interface.	Flexibility for the user embedding the licensing mechanism into his workflows.
Co-scheduling of licenses and computational resources	Select the most appropriate resources depending on actual requirements and have the necessary licenses available.
Reservation in advance	Licenses can be reserved for later use, and coordinated with the availability of computational resources.
License token	Allows execution completely decoupled from the site that hosts the license server.
Trusted entity available at execution site	Allows re-negotiation at run-time, e.g. giving up a license before the reservation period is over, trying to extend a reservation period, or adding new features. Thus, the license usage may be adapted to the real need. This allows reducing the cost either by not paying for times where the license is unused, or by avoiding an application crashing because the license was no longer valid.
Increased flexibility through token mechanism for the implementation of new usage models, e.g. pay-per-use.	Pay-per-use schemas allowing end users, in particular SMEs, to use software they could not afford with the traditional licensing models.

Use-cases

The following list depicts selected use-cases for elasticLM:

- Run license protected applications on (remote) Grid or Cloud resources using licenses from your local license pool
- ASP outsourcing
  - Outsource application execution to an ASP using licenses of the local license pool
  - One ASP is forwarding large jobs to another ASP
  - Reuse of existing licenses
- Use of Test licenses in virtualised environments
  - Provide infrastructure for freelance software developers
- Aggregation of licenses from different license pools,
  - e.g. local ones, ASP ones or from a Broker to run an application exceeding the locally available licenses
- License brokering
- Local use in (multi-)cluster environments without Grid or Cloud infrastructure
- Advance reservation of licenses, co-scheduling of licenses and other computational resources
- Extend/Reduce license terms when job is running.

Business models for ISVs and ASPs

In the SmartLM project we addressed both new business models and the technology supporting these business models for the emerging service and virtualization environments as well as in traditional cluster environments. elasticLM picks up both focal points of the SmartLM development extending the prototype to a product.

elasticLM is designed to support new business models, e.g. through aggregation or extension of licenses, along with service-oriented business models, e.g. budget-controlled pay per use, SaaS, use of remote resources for application execution. Naturally, elasticLM supports traditional license usage scenarios also.

Our analysis of existing business models, the analysis of current vendor and user issues and the examination of the impact of new license mechanisms result in the paradigm governing the development process: provide features allowing to create a Win-Win Situation for ISVs and users with elasticLM.

Integration in Applications

A single module implements the application's elasticLM interface. In the basic scenario, this API acts as a policy decision point decrypting the license terms, verifying the signature and analysing the terms. The result is provided to the application for further processing as usual.

In the advanced scenario the trusted entity is in charge of decrypting the license terms, verifying the signature and analysing the terms and forwards the results to the API. Moreover, the elasticLM API may provide advanced capabilities when connected to a trusted entity, e.g.

- trusted clock
- re-negotiation of license terms at run-time
- providing actual usage information to update the initial usage record

Since the elasticLM API implements the interface of the existing policy enforcement point in the application, there is no need to change the existing policy enforcement point in the application. elasticLM provides different language bindings depending on the application.

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SmartLM Partner