



Domain 12: Guidance for Identity & Access Management V2.1

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Introduction

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Identity and Access Management

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Introduction

Managing identities and access control for enterprise applications remains one of the greatest challenges facing IT today. While an enterprise may be able to leverage several cloud computing services without a good identity and access management strategy, in the long run extending an organization's identity services into the cloud is a necessary prerequisite for strategic use of on-demand computing services. Supporting today's aggressive adoption of an admittedly immature cloud ecosystem requires an honest assessment of an organization's readiness to conduct cloud-based Identity and Access Management (IAM), as well as understanding the capabilities of the organization's cloud computing providers.

We will discuss the following major IAM functions that are essential for successful and effective management of identities in the cloud:

- Identity provisioning/deprovisioning
- Authentication & federation
- Authorization & user profile management
- Support for compliance

The SPI (**S**aaS, **P**aaS, **I**aaS) cloud delivery models call for IT departments and the cloud service provider (CSP) to jointly extend the organization's IAM practices, processes, and procedures to cloud services in ways that are scalable, effective, and efficient for both the provider and its customers.

Identity Provisioning: One of the major challenges for organizations adopting cloud computing services is the secure and timely management of on-boarding (provisioning) and off-boarding (deprovisioning) of users in the cloud. Further, enterprises that have invested in user management processes within an enterprise will seek to extend those processes to cloud services.

Authentication: When organizations utilize cloud services, authenticating users in a trustworthy and manageable manner is a vital requirement. Organizations must address authentication-related challenges such as credential management, strong authentication, delegated authentication, and managing trust across all types of cloud services.

Federation: In the cloud computing environment, Federated Identity Management plays a vital role in enabling organizations to authenticate their users of cloud services using the organization's chosen identity provider (IdP). In that context, exchanging identity attributes between the service provider (SP) and the IdP securely is also a requirement. Organizations considering federated

identity management in the cloud should understand the various challenges and possible solutions to address those challenges with respect to identity lifecycle management, available authentication methods to protect confidentiality, and integrity, while supporting non-repudiation.

Authorization and User Profile Management: The requirements for user profiles and access control policy vary, depending on whether the user is acting on their own behalf (such as a consumer) or as a member of an organization (such as an employer, university, hospital, or other enterprise). The access control requirements in SPI environments include establishing trusted user profile and policy information, using it to control access within the cloud service, and doing this in an auditable way.

Compliance: For customers who rely on cloud services, it is important to understand how Identity Management can enable compliance with internal or regulatory requirements. Well designed identity management can ensure that information about accounts, access grants, and segregation of duty enforcement at cloud providers, can all be pulled together to satisfy an enterprise's audit and compliance reporting requirements.

For each of these IAM functions, we will discuss the challenges, solutions, and future outlook; and present a provider check list and set of questions to will help you get ready for cloud adoption.

Identity Provisioning

Identity provisioning practice within an organization deals with the provisioning and de-provisioning of various types of user accounts (e.g., end user, application administrator, IT administrator, supervisor, developer, billing administrator) to cloud services. It is very common for cloud services to rely on a registry of users, each representing either an individual or an organization, maintained by the cloud service provider (CSP) to support billing, authentication, authorization, federation, and auditing processes.

Identity Provisioning: Requirements

Software as a Service

Organizations adopting SaaS services require provisioning of business users (either in small or large batches) with rapid turnaround. If the business relies on a third party to support outsourced business processing, it will require provisioning of third party users. Businesses may also dictate provisioning of users with varying levels of privilege (roles) required by their job functions.

Multi-stage setup: Login capability alone may be insufficient to ensure the target user is functional, an expected outcome of any provisioning process. Some SaaS applications may require multi-step user establishment through provisioning. Users cannot be instantiated by merely creating an account with login credentials, but must be created and subsequently assigned to business level objects, such as sales territories, with appropriate permissions and authorization.

Application setup workflow: Organizations that are adopting SaaS for mission critical solutions will often need to coordinate and sequence application provisioning and permissions. Examples might include sales processes with lead generation, sales automation, and compensation management tools. Successful application alignment may require coordinated provisioning of granular permissions across multiple SaaS applications and sequencing of user instantiation. Using an industry standard such as the Service Provisioning Markup Language (SPML) can enable automation of some of these processes.

Communications Security: When provisioning users in public cloud services, provisioning requests may travel over an open Internet (rather than inside a data center) so customers need to pay more attention to communication security. SSL enables confidentiality and integrity of communications. Also, if federation is used, provisioning must be done in a way that supports auditing by correlating identity across logs from different SaaS providers.

Platform as a Service

Regarding identity, PaaS providers may fall into 2 categories:

1. Have an established identity provider service for users.
2. Rely on customers to provide their own identity. *i.e.*, those who have identity providers may leverage their existing identity provisioning.

PaaS environments typically cater to developers. In addition to provisioning developers to the PaaS services, there is a requirement to provision end users to custom applications hosted on the PaaS platform. Major requirements include:

- Automated provisioning (single user, bulk users) that supports an organization standard such as SPML. Each user may have to be provisioned with appropriate privileges (administrator, developer, tester, end user)
- Developers may want to provision accounts for the end users of their applications. In this case, the developers will require the PaaS platform to

support roles such as Developers, Administrators, and End Users.

- API support for provisioning users of PaaS applications. Developers may need multiple accounts for testing and may need to provision thousands of ephemeral test users.
- Manual provisioning may also be required for small and medium sized businesses, and individual consumer users of PaaS environments. In this case, the cloud's identity services must support delegated administration so administration of the cloud's identity service can be parceled out to the individual owners (developers) of each PaaS environment, and each administrator can manage accounts only within their own environments.

Infrastructure as a Service

IaaS platforms typically cater to developers and IT administrators. Thus provisioning of users (IT administrators) will follow data center privilege management requirements. Typical roles may include Billing Manager, System Administrator, Network Engineer, Backup Manager, and Firewall Administrator. Since IaaS systems typically support the creation and life cycle management of virtual servers; granular privileges to create, destroy, start, stop, export, import, and suspend virtual machines may be required for billing, compliance (segregation of duties, least privileges) and security reasons.

Businesses adapting IaaS cloud services need the flexibility to provision a few types of users to meet cyclic demands (elasticity), set budget limits on a weekly/monthly basis, and have clear user accountability to prevent and detect any fraud by insiders.

Requirements can be summarized as:

- Automated provisioning support using an organization standard such as SPML.
- Provisioning of users with appropriate privileges based on roles (billing administrator, system administrator, developer, tester, end user)
- API support for provisioning users.

Identity Provisioning: Challenges

Software as a Service

The rapid evolution of complex SaaS provisioning and limited proprietary support for user profiles have outpaced the standards efforts, especially as part of a complex business processes.

Standards such as SPML have not been materially updated in three to four years; while the aggressive pace of SaaS development has created multiple

distinct ways of provisioning and managing user profiles. In many cases, industry leading SaaS CSPs have elected to not move forward and invest until a clear, dominant set of standards emerges. Where utilized, the standards do not yet offer sufficient depth in provisioning and management.

Other challenges:

- CSPs may follow proprietary schemes to support user provisioning and lifecycle management of user profiles.
- For individual consumers (not associated with an organization), an SPML provider is not an option since they lack an authoritative 3rd party source for such requests.

Platform as a Service

The challenges with PaaS can be similar to SaaS, in addition to providing the necessary provisioning capabilities to the developers in the form of APIs. Currently, APIs that support provisioning on PaaS platforms are lacking. Most PaaS providers offer simple web forms to create user accounts and associate them with user profiles (groups).

Infrastructure as a Service

User provisioning in IaaS involves provisioning of both privileged and business users to VPN gateways, hosts, and applications. Organizations are challenged to follow proprietary mechanisms to manage identities within IaaS clouds e.g., to set up accounts for the organization's cloud manager for billing reasons, and then delegate system account provisioning to the application owner.

Identity Provisioning: Solutions and Recommendations

While user provisioning remains a major challenge and barrier for cloud service adoption, the capabilities offered by CSPs are not currently sufficient to meet enterprise requirements. To avoid one-off custom solutions that exacerbate management complexity, customers should avoid proprietary solutions such as creating custom connectors unique to CSPs. Customers should leverage standard connectors provided by CSPs to the extent practical, preferably built on SPML schema. Since SPML has been recognized as the industry standard specification for user access provisioning for multiple types of applications, any custom solution should leverage SPML so that it can be repurposed to suit a standard CSP supported solution. Cloud customers should modify or extend their authoritative repository of identity data to encompass applications and

processes in the cloud.

In SPI cases where CSPs do not support provisioning management using SPML, customers should request their CSPs to offer SPML based provisioning web services.

Technical Solution Options

Software as a Service/Platform as a Service

1. Use native SPML adapters or connectors provided by the CSP
2. Use SPML gateways to provision users in CSPs that do not have native support for SPML.
3. When supported, provision accounts dynamically using attributes in a Security Assertion Markup Language (SAML) authentication assertion.
4. Periodically audit users and their privileges; delete unauthorized users and minimize privileges by assigning the appropriate profiles for users.
Automate processes to scale across providers.

Infrastructure as a Service

1. Leverage a CSP supported API to provision users in CSPs.
2. Configure standard virtual machine images with pre-populated users and groups who need access to the virtual machines ('guests' or 'images'). The users and groups should be aligned with corporate LDAP or Active Directory status. Least privilege principle should be followed when provisioning access to OS and application services.
3. Caution must be exercised when storing credentials in pre-configured virtual machine images. Where possible, credentials should be set or changed as part of (or immediately after) the provisioning process.
4. Periodically audit virtual machine images and remove users as necessary.

Identity Provisioning: Questions for Your Provider and Assessment Checklist

Software as a Service / Platform as a Service

1. What provisioning standards do you support today?
2. Do you support SPML? What version? If so, do you have a schema?
3. Do you offer web services for automated provisioning (bulk or single)?
4. Do you offer on the fly (just-in-time) provisioning, whereby users are provisioned using a pre-assigned token but activated at the time of online registration?

5. What language support do you offer for clients of provisioning web services? Examples include Java, .NET, Ruby on Rails, PHP, etc.
6. Do you support provisioning via transient federation (SAML)?
7. What logging of provisioning requests is performed, and how is it protected from tampering? What reconciliation mechanisms are available?

Infrastructure as a Service

1. What provisioning standards do you support today?
2. Do you offer API support for provisioning/deprovisioning users of compute service?
3. Do you offer API support for provisioning/deprovisioning users of storage service?
4. Do you have an API that support management of privileged users who configure virtual network resources including load balancers, firewall policies and network segmentation?
5. Does the API offer support for provisioning/deprovisioning privileged users?

Identity Provisioning: Future Outlook

With the rapid adoption of cloud services, customers must find ways to automate the provisioning and deprovisioning of users using industry standard specifications such as SPML and web APIs. The cloud environment offers an opportunity to move away from custom connectors and proprietary APIs and towards standards such as SPML and web APIs. SPML gateways can automate user provisioning and eliminate laborious manual processes that may involve custom scripts to setup user accounts with cloud services.

Software as a Service / Platform as a Service

- SPML adoption by CSPs and support for automated provisioning with workflows.
- Customer adoption of automated provisioning using CSP supplied connectors.
- Support for transient provisioning using SAML.
- PaaS provider support for delegated user administration to owners of applications hosted in the PaaS platform.

Infrastructure as a Service

- Privileged user management via APIs, and delegated administration for virtual machine and storage administrators (owners).

Authentication

Authentication is the process of validating or confirming that access credentials provided by a user (for instance, a user ID and password) are valid. A user in this case could be a person, another application, or a service; all should be required to authenticate. Many enterprise applications require that users authenticate before allowing access. Authorization, the process of granting access to requested resources, is pointless without suitable authentication. When organizations begin to utilize applications in the cloud, authenticating users in a trustworthy and manageable manner becomes an additional challenge. Organizations must address authentication-related challenges such as credential management, strong authentication, delegated authentication, and trust across all types of cloud delivery models (SPI).

Authentication: Requirements and Challenges

Credential Management involves issuing and managing credentials for an organization's users. While creation of a user and managing the life cycle is addressed by identity provisioning, the authentication challenge is to manage credentials including passwords, digital certificates, and dynamic credentials. Organizations which rely on usernames and passwords to authenticate users should consider the following challenges:

- Protecting the password and communicating it securely.
- Impersonation: When the same password is used for various cloud services, an insider or an attacker who can gain access to the password store might capture passwords and impersonate users at other sites.
- Protecting the passwords from brute force dictionary based password attacks as well as attacks that target self servicing functions like password resets.
- Phishing: Cloud users may be lured to a rogue site to give away their usernames and passwords. Phishing attacks can also install malware and keystroke loggers that capture usernames and passwords.
- Defining and enforcing a password / credential policy in the cloud, including:
 - Credential lifetime: How long are the credentials valid?
 - Credentials strength: Password length, certificate key strength, etc.
 - Security of the stored credentials: Are they one-way hashed? What is the data store?
 - Self Service password reset.
 - Verification of identity before password reset.

Certain high risk or high value applications might require strong authentication technology such as one time passwords (OTP) or digital certificates. Strong and multi-factor authentication are becoming more common, especially in large enterprises; however, individual methods may or may not be compatible with a given cloud service or cloud application. Cost, administrative overhead, and user acceptance issues can make adoption of multiple strong authentication methods – one set for internal enterprise applications, and another for the cloud – problematic. The same challenges apply to cloud providers as well, as it may not be cost effective to support multiple strong authentication mechanisms to accommodate incompatible client requirements. Therefore, the ability to support existing methods is a significant selection factor for cloud services.

Customers should seek out SaaS and PaaS providers which support the following:

1. Authenticating users by means of username and password (at minimum) along with stronger authentication options commensurate with the risk level of the services being offered.
2. Enterprise administration capabilities including administration of privileged users for all supported authentication methods.
3. Self-service password reset functions that validate identity first.
4. The capability to define and enforce strong password policies.
5. Federated authentication: a means of delegating authentication to the organization that uses the SaaS application.
6. User-centric authentication (such as OpenID) – especially if the application is accessible by individuals. User-centric authentication mechanisms such as Google or Yahoo IDs enable users to sign in using existing credentials that need not be stored by the consuming site.

Authentication: Solutions and Recommendations

Both the cloud provider and the enterprises must consider the challenges associated with credential management, and strong authentication; and implement cost effective solutions that reduce the risk appropriately.

SaaS and PaaS

Credential management presents a significant challenge in any environment. In SaaS and PaaS cloud environments, various options are available based on the type of cloud service.

SaaS and PaaS providers typically offer built-in authentication services to their applications or platforms, and alternately support delegating authentication to the

enterprise.

Customers have the following options:

- Enterprise: Consider authenticating users with the enterprise's Identity Provider (IdP) and establishing trust with the SaaS vendor by federation.
- Individual user (acting on their own behalf): Consider using user-centric authentication such as Google, Yahoo ID, OpenID, Live ID, etc., to enable use of a single set of credentials at multiple sites.

Note: Any SaaS provider that requires proprietary methods to delegate authentication (e.g., handling trust by means of a shared encrypted cookie or other means) be carefully considered with a proper security evaluation before proceeding. The general preference should be for the use of open standards.

IaaS

In IaaS, two sets of users need to be authenticated. The first set of users is enterprise IT personnel, who will deploy applications and manage applications. The second set is application users; who might be employees, customers, or partner organizations. For IT personnel, establishing a dedicated VPN is generally a better option, as they can leverage existing systems and processes.

With IaaS, the cloud provider has little say in how applications authenticate their users. It's the organization deploying applications in the cloud that decides how to perform authentication. Possible solutions include creating a dedicated VPN tunnel to the corporate network or federation. A dedicated VPN tunnel will work better when the application leverages existing identity management systems, such as a single sign-on (SSO) solution or an LDAP-based authentication service that provides an authoritative source of identity data.

In cases where a dedicated VPN tunnel is not feasible, applications should be designed to accept authentication assertions in various formats (SAML, WS-Federation, etc), in combination with standard web encryption such as SSL. This approach enables the organizations federate SSO outside the enterprise, extending it to cloud applications.

OpenID is another option when the application is targeted beyond enterprise users. However, because control of OpenID credentials is outside the enterprise, the access privileges extended to such users should be limited appropriately.

Applications may also have the ability to authenticate against their own data stores. While this option does address the need to authenticate users, it will soon create a challenge in terms of managing credentials and SSO. Any locally implemented authentication service within the cloud provider should be OATH compliant. With an OATH-compliant solution, companies can avoid becoming

locked into one vendor's authentication credentials. OATH-compliant systems can support any similarly compliant form factor, including tokens, cell phones, and PDAs. More than 70 manufacturers produce OATH-compliant solutions today, providing organizations an enormous variety of options for the consumers they serve.

Private IaaS Clouds

Organizations that are deploying applications in their own private clouds should consider managing authentication outside their application but still within the enterprise. External systems such as SSO/Web Access Management systems can provide not only authentication but also password management and self service features. External authentication enables acceptance of SAML tokens, enabling migration to a different cloud provider if desired.

Strong Authentication

“Strong authentication” typically refers to multi-factor authentication or authentication protected by cryptographic means. Strong authentication methods such as Kerberos, and token or smart-card systems are common within enterprise networks, and the enterprise should consider leveraging this technology for use in the IaaS cloud, especially for privileged access management or shell access using Secure Shell (SSH).

In order to enable strong authentication (regardless of technology), cloud applications should support the capability to delegate authentication to the enterprise that is consuming the services. In that case, the enterprise can enforce strong authentication using existing infrastructure and authenticate with open standards such as SAML with the cloud provider / application.

Cloud providers should externalize authentications and consider supporting various strong authentication options such as one time passwords, biometrics, digital certificates, and Kerberos. This will provide a pluggable authentication architecture and enable enterprises to leverage their existing infrastructure.

Federation

In the cloud-computing environment, federation of identity plays a key role in enabling allied enterprises to authenticate, provide single or reduced sign-on, and exchange identity attributes between the Service Provider (SP) and the Identity Provider (IdP). Organizations considering federated identity management in the cloud should understand the various challenges and possible solutions to address those challenges with respect to identity lifecycle

management, authentication methods, token formats, and non-repudiation. Non-repudiation is a major potential benefit of federation, as it provides a mechanism to trust or verify that the identity assertions came from the trusted IdP rather than an impostor.

In discussing federation, we consider two primary roles:

- **Service Provider (SP):** An internally deployed application or cloud service.
- **Identity Provider (IdP):** An authoritative source of identity data for users provides the primary authentication of the user. The Identity Provider can be the service consumer itself, or external to it.

Single Sign-On

As organizations start to use various cloud services, they expand the importance of providing SSO to various applications not just within their enterprise, but also to applications in clouds the organization hosts or subscribes to.

Individual Consumers: The choices for users accessing public cloud applications include supplying a username and password from a provider such as Yahoo or Google; or a more sophisticated authentication using OpenID, Microsoft Live ID, or another service that offers delegated authentication without providing the actual password to the cloud application itself.

The OpenID protocol is a popular user-centric SSO protocol.

If user-centric solutions are not appropriate (for instance, for an enterprise), then local authentication (with appropriate identity validation) or use of a trusted third party service will be required to establish reliable identity information for users, and is essential for supporting access control.

Enterprises have the following two federated SSO options:

- **Federated Public SSO:** Based on standards such as SAML or WS-Federation, enterprises can provide SSO to various cloud applications that support federation.
- **Federated Private SSO:** Organizations using a private cloud can leverage their existing SSO architecture over a VPN tunnel or secured private connection to provide SSO to applications in the cloud.

Multiple Federation Standards

Enterprises looking for a cloud provider should verify that the provider supports at least one of the prominent standards (SAML or WS-Federation). SAML is

emerging as a widely supported federation standard and is supported by major SaaS and PaaS CSPs. Support for multiple standards will enable greater flexibility.

CSPs should be flexible enough to accept the standard federation formats from different Identity providers. However, as of this writing, most CSPs only support a single standard, such as SAML 1.1 or SAML 2.0. CSPs desiring to support multiple federation token formats should consider implementing some type of federation gateway, defined later in this section.

SAML for Web SSO

SAML is a widely accepted federation standard supported by service providers and most commercial and open source federation products. SAML 2.0 combines the Liberty ID-FF (Identity Federation Framework) with SAML v1 and proprietary extensions. Even enterprises considering only Web SSO should verify that their cloud provider at least supports one version of SAML.

Identity Provider: Support for multiple standards

Organizations adopting cloud services should be aware that cloud services may support different federation standards. If the organization plans to leverage multiple cloud providers for their business or federate with multiple other entities, they should be prepared to support issuance of tokens in multiple standards such as SAML and WS-Federation. The organization's IdP should have the flexibility to federate their identities using a standard supported by the cloud service provider.

Federation Gateways

Federation gateways are an architectural option where the enterprise externalizes its federation implementation to manage the issuance and verification of tokens. Using this method, organizations can delegate issuing various token types to the federation gateway, so the gateway handles the core work of translating tokens from one format to another. The federation gateway may be located either in a trusted internal network or in the cloud (Identity as a Service).

Single Sign-On Authentication Model and Authentication Strength

User-centric single sign-on models such as OpenID allow users to choose their authentication services! This is appropriate where the access control requirements can be satisfied with self-asserted identity and attributes. In other words, if it's acceptable for someone named John Smith to use an account with a

pseudonym, then user-centric identity will suffice and offers convenience for users. Obviously, for banking services and others that depend on knowing who the user really is self-asserted user-centric identity is not an appropriate solution. Similarly, corporate access control requirements cannot be satisfied by self-asserted identity schemes. Other single sign-on models such as SAML allow the cloud service provider or the user's organization to select the allowed authentication service(s), providing more control over the quality of security practices. In a similar vein, the strength of the authentication mechanism chosen should take into account access control requirements, because authentication provides the user identity information upon which access control decisions are made. Unlike models such as OpenID, SAML can indicate the strength of authentication used by the external authentication service. With the wide variety of single sign-on authentication implementations, it is important not to enable inadequate authentication mechanisms for access to sensitive services.

Questions for Vendors / Cloud Providers:

- What federation standards do you support?
- If you support federation standards like SAML, do you provide toolkit, documentation and support for integration with enterprise identity provider?
- What processes and procedures do you have in place to protect digital certificates?
- How does the provider manage session time outs? Is it policy based?

Access Control and User Profile Management

A user profile is a set of user attributes used by a cloud service to customize the service and possibly restrict access to portions of the service. Access control is the granting of access to particular resources, and the auditable enforcement of that policy. Access control depends on accurate user profile information in order to make appropriate policy decisions.

The requirements for user profiles and access control policy vary depending on whether the user is acting on their own behalf or as a member of an organization such as an employer, university, hospital, or other agency. When a user acts on their own behalf they are the sole source of profile information about themselves, and policy is set by the cloud provider. When a user acts on behalf of an organization, however, that organization may be the authoritative source for some of the user's profile attributes, as well as an access control policy which

applies to the user. This section on access control uses the term ‘consumer user’ for someone acting on their own behalf and ‘corporate user’ for someone acting on behalf of an organization, such as their employer.

In a cloud computing environment, therefore, user profile and access control management are more challenging because the information for these functions may come from different sources; using different processes, naming conventions, and technology; and may need to be transmitted securely between organizations over a hostile Internet. The sections below further describe access control and user profile requirements for each category of cloud computing.

Access Control: Cloud Challenges

Access control and user profile management are more challenging with cloud services because the information sources may be hosted somewhere other than the cloud service that needs them. Customers need to identify trusted sources for this information and secure mechanisms for transmitting the information from the trusted source to the cloud service. It is also important to periodically reconcile the information between the cloud service and the source.

Customers need to confirm that cloud providers can support their needs for adequate access control of cloud resources by checking to ensure that the cloud will:

- Control access to the cloud service’s features based on policy specified by the customer, as well as the level of service purchased by either the individual user or the organization to which the user belongs.
- Control access to each user’s data to protect it from other cloud service customers in multi-tenant environments. Adequately control access to both regular user functions and privileged administrative functions. Allow collection of user profile information, and possibly access control policy, from a remote service chosen by the customer.
- Keep user profile information and access control policy accurate.
- Provide optional notification of account creation/removal and access grants to the customer, to prevent cloud employees from setting up rogue accounts or otherwise modifying access entitlements.
- Provide adequate audit logs of activity within each customer’s environment, including identity management and access activity, as well as use of any resource for which quotas are enforced.
- Provide solutions for determining liability for various problems which may occur.

In short, customer requirements for a cloud environment are similar to internal

services, but there are several important differences. First, customers will want cloud services to solve the above requirements in a way that provides adequate protection in shared, multi-tenant environments. Second, the solutions must accommodate user profile and policy information from remote sources and a need for periodic reconciliation against those remote sources. Third, cloud services need to acknowledge that the right identity management solution(s) for a service depend on whether a user is acting on their own behalf or on behalf of some organization, and whether single sign-on is a requirement.

Software as a Service

The above section described customer access control requirements common to SaaS, PaaS, and IaaS environments. In addition, customers of SaaS services want cloud providers to:

- Allow users to specify external entities with which the user's data may be shared.
- Allow users to make their data available to composite applications (mashups).
- Allow users to delegate some privileges to other members of their organizations.
- Support web service access from remote programs.

Platform as a Service

Customer access requirements in PaaS environments center on protecting access to the development environment, the code repository, common services, and the ability to promote or demote code between development, test, and production environments. Customers should check to ensure the cloud will:

- Control the ability to access the customer's code repository and development environment in a multi-tenant situation.
- Enable developer access to any common services such as databases, directory services, and file systems without allowing any customer to see or impact another customer's entries in those services.
- Protect the ability to move code between development, test, and production environments.
- Allow developers and testers to create test users for their applications, and specify access control policy.

This is more difficult in a cloud scenario because the development environments of one PaaS customer must not be accessible by another unrelated PaaS customer, even though they may reside on the same virtualized infrastructure

and might share a database instance.

Infrastructure as a Service

In an IaaS environment, customers want access management features that enable them to set up a variety of services while protecting their environments from other cloud users. Customers should confirm that the cloud service will allow them to:

- Provision and configure virtual machines and guest operating systems.
- Access virtualized storage services from their virtual compute environments.
- Request necessary network interfaces, firewall rules, load balancer policies and name service entries.
- Use services such as databases, directory services, and web servers.
- Provision and maintain user accounts for IT personnel, developers, and application administrators.

The new challenge in a cloud environment is that for cost effectiveness this provisioning must be standardized, virtualized, and automated with pre-built images where possible. However, it is imperative to set up unique accounts, rules, and policy for each customer so that one IaaS customer cannot see or gain access to another customer's environment. As an example, a cloud provider should not give an IaaS customer so much network configuration access that they can alter or request firewall rules or poison name service entries in a way that impacts another IaaS customer. With a great deal of immaturity in cloud vendor practices, customers should carefully review vendor practices to ensure that resources in the cloud service are adequately protected and that areas of trust are clearly understood.

Access Control: Solutions and Recommendations

Access control considerations and solutions are similar across SaaS, PaaS, and IaaS services. This section first discusses access control in general, and then covers the specifics of each cloud category further below.

The challenge in selecting or reviewing the adequacy of access control solutions for cloud services is multifaceted, and can be broken into the following tasks.

1. Review appropriateness of the access control model for the type of service or data.
2. Identify authoritative sources of policy and user profile information.
3. Assess support for necessary data privacy policies.

4. Select a format for specification of policy and user information.
5. Determine the mechanism for transmission of policy from a Policy Administration Point (PAP) to Policy Decision Points (PDP).
6. Determine the mechanism to transmit user information from a Policy Information Point (PIP) to a Policy Decision Point (PDP).
7. Review method for requesting policy decisions from a Policy Decision Point (PDP).
8. Review enforcement of policy decisions at Policy Enforcement Points (PEP).
9. Log information necessary for audits.

1. Access Control Model

There are several different access control models, but in general the model that is good for a particular situation in a non-cloud model will still be appropriate in a cloud situation. Transaction processing services may be best served by Role Based Access Control (RBAC) models, possibly complemented by data-centric policy (such as SQL views) implemented in underlying databases. Unstructured content may be best protected by an ACL model in many cases, and a MAC/MLS model when it is necessary to make access control decisions based upon the classification of assets or information. Web service access to the cloud is generally best supported by an ACL model. In addition to basic access control, cloud environments may impose quota-based restrictions. Customers should make sure they fully understand the capabilities and limitations of the access model in use. Finally, large corporate customers will need to invest in designing a group or role model that maps user roles to their internal business functions in order to effectively manage the access model.

2. Authoritative Source

Customers should identify appropriate sources of policy and user profile information and ensure that the cloud will use only such trusted sources. The appropriate source depends on the type of user. Regarding users acting on their own behalf, the user will be the primary source of profile information, and the cloud service the primary source of policy. Self-asserted identity schemes such as OpenID that allow the individual users to select an identity provider are appropriate for services that don't involve sensitive information. For 'corporate' users, however, policy information must come from the user's organization as well as the cloud, and user profile information must come from the user's organization as well as the user. As discussed in the authentication section above, identity schemes such as SAML, which allow the organization to select the identity provider and to require a particular strength of authentication, are necessary for this case. If the cloud service only offers local identity services,

customers should determine how to provision, deprovision, and audit identity information at the cloud service. In short, customers should ensure that a cloud service will use appropriate sources of policy and user profile information.

3. Privacy Policy

Privacy requirements varies greatly between different countries and data content, but it is always important for collaborating sites to exchange and enforce privacy and consent directives. For enterprise customers of cloud services, the cross-enterprise Security and Privacy Authorization (XSPA) profile of XACML, currently in draft, helps entities exchange information about privacy requirements. Enterprise cloud customers should understand this profile and what it provides. Privacy features for consumer users are decided and implemented locally by cloud providers.

4. Access Control Policy Format

For consumer users, all policy is specified locally at the cloud service. However, the use of cloud services by members of corporations and other organizations introduces the possibility that access control policy may be specified in one place, such as the organization, and transmitted to another place, such as the cloud service provider. If every cloud service provider and every customer invent their own format for representing policy information, an unsustainable situation results. The industry standard eXtensible Access Control Markup Language (XACML) represents access control policy in a standard way. WS-Policy is a lesser-known alternative, for those using the WS-Federation standard for web services.

Even with an industry standard, the sender and recipient still need to agree on the names and semantics used within the requests. For example, a cloud service provider may have a service role called 'manager' or 'admin' that entitles a user to specific capabilities within the service. A corporate customer may also have its own internal role of that name which is quite different. If access control policy is specified in a centralized fashion within a corporation (for the sake of visibility and manageability), a scheme will be needed to translate from corporate roles/policy to cloud provider roles/policy and to eliminate confusion caused by name conflicts. There are no standards for this task at this time, as it is highly specific to each cloud service.

5. Policy Transmission

For users acting on behalf of some organization, such as their employer, it may be necessary for access control policy to be transmitted from the organization to the cloud service provider. This information can be transmitted in a periodic batch fashion or 'just-in-time' with each user request. If every cloud service

provider and every customer invents their own mechanism for encrypting and transporting policy information over the Internet, again, an unsustainable mess occurs. If information is to be transmitted in a periodic batch fashion, the industry standard SPML (Service Provisioning Markup Language) should be used. Though this standard is not widely adopted yet, increasing use of cloud services by corporate entities will drive higher adoption. If a SAML single sign-on model is in place, and the cloud service is capable of receiving policy information from SAML assertions, policy information can be transmitted within digitally signed SAML assertions. This option would use the SAML2.0 profile of XACML. Similarly, for those who've chosen to implement WS-Federation; the WS-Policy, WS-PolicyAttachment, WS-Federation, and WS-Trust specifications could be used; but these are not widely deployed in practice. Finally, for users acting on their own behalf, or when policy is specified at the cloud provider, no policy transmission solution is needed.

6. User Profile Transmission

There are many options for obtaining user profile information on which to base access control decisions, and the choice between them is determined to an extent by the choice of single sign-on (SSO) scheme. Any user can self register at the cloud provider and fill in their user profile information manually if self-asserted user profile information is acceptable. If the cloud service allows use of a self-asserted single sign-on scheme such as OpenID, or Google or Yahoo accounts, user profile attributes can be retrieved from those providers. Windows CardSpace with self-issued cards, while not widely used, is another possibility. These mechanisms are unlikely to provide all the attributes needed by a cloud provider, so may need to be supplemented by manual profile specification on the part of the user. They are also unlikely to be suitable for corporate use.

For corporate users, or any other case where self-asserted identity is not acceptable, user profile information must be obtained from a trusted source — typically the organization on whose behalf they are acting. If SPML services are used to transmit policy information, this same scheme can be leveraged for user profile information. If SAML single sign-on is used, then user profile information needed by the service can be transmitted within the SAML assertions or obtained from an attribute provider service via web service calls using SAML or ID-WSF. If WS-Federation single sign-on is used, WS-Policy claims can carry profile information. If CardSpace with managed Information Cards is used, then profile information can be obtained from the cards, though thought should be given to how frequently profile information changes and the ease with which managed cards can be updated.

Alternatively, a cloud service could use OAuth to allow a user to programmatically share their own content at one provider with their account at another provider. OAuth requires a prior relationship between the consuming service and the providing service, and as such could be used for either self-asserted or corporate

scenarios. OAuth is not yet widely implemented, but as an independent SSO scheme it may prove popular, particularly in less sensitive, self-asserted identity circles such as OpenID.

Attribute certificates are another possibility, most appropriate for attributes which don't change frequently, but these require issuing infrastructure and procedures to maintain the integrity of the information and are not widely used in practice, so we will not discuss them further.

In summary, there are many mechanisms for obtaining user profile information from remote sources. The user-centricity of the access control requirements and the choice of single sign-on mechanism narrow the possibilities. Though SAML may be the most widely used scheme at present, cloud providers and customers may need to support more than one of these options because it is unlikely that any one mechanism will win out in the near future as right for all situations.

7. Policy Decision Request

If the authorization decision is handled outside a cloud service, the industry standard XACML can be used to express the policy question and the response, transmitted via SAML assertion. Alternatively, for those willing to implement the full WS-* set of specifications, WS-Security, WS-Trust, WS-Federation, WS-Policy, and WS-PolicyAttachment can be used but are not widely deployed. In practice, few applications to date have been designed to externalize authorization decisions. This may change in the future if corporate customers want to leverage cloud services while retaining control over access control decisions for security, auditability and liability reasons. Widespread change in this direction is not expected soon.

8. Policy Decision Enforcement

Enforcement of access control policy remains largely within applications and cloud services. In the case of web services, access control policy can be enforced by a web service gateway, which can alleviate some, but not all of the responsibility on web services for access control enforcement.

9. Audit Logs

Access control activity must produce logs with enough information to meet auditing requirements and possibly to support usage charges. There is a lack of applicable standards at this time, so cloud providers and customers, particularly corporate customers must work together to determine the information needed, how to make it available and how to protect the confidentiality, integrity, and availability of this information. Cloud customers should ensure that one customer's access to log information does not give them information about other customers.

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Corporate customers may require regular access to information about who from their organization has accounts, which accounts have which privileges, and who authorized each account and privilege; and need proof that segregation of duty and prompt deprovisioning of accounts and entitlements have been enforced. In addition, if identity federation has been used, logs should provide enough information that corporate customers can correlate and reconcile identity information from the cloud provider with internal company records.

The use of cloud services by corporate customers creates new challenges for meeting audit requirements due to the scattering of policy and log information across domains; and the ephemeral nature of services in a virtualized, dynamic cloud infrastructure. Corporate cloud customers need to review the extent to which a cloud service can meet their specific needs for auditing, governance, and compliance.

Summary Table

The following table summarizes the advice of the above sections and shows the most common recommendation from those sections. Where multiple solutions are listed the above sections should be consulted for information on the conditions, which might influence the decision between them.

	Identity Mgmt Task	Consumer User	Corporate User	Web Service
1	Access Control Model	RBAC, ACL	RBAC, ACL	ACL RBAC if requests on behalf of specific user
2a	Authoritative Source – User Data	The user Local registration or OpenID	The user’s organization The user SPML or SAML	Varies depending on type of user and the web service client SPML or SAML
2b	Authoritative Source – Policy Data	The cloud provider	The user’s organization The cloud provider SPML or SAML	Information owner The cloud provider SPML or SAML
3	Privacy Policy	The cloud provider Implement locally	The user’s organization XSPA profile for XACML	Client organization XSPA profile for XACML
4	Access Control Policy Format	XACML	XACML	XACML
5	Policy Transmission	N/A	SPML or SAML 2.0 profile of XACML	SPML or SAML 2.0 profile of XACML
6	User Profile Transmission	OAuth	SAML assertion OAuth	SAML assertion
7	Policy Decision Request	N/A	XACML, SAML2.0 profile of XACML	XACML, SAML2.0 profile of XACML
8	Policy Decision Enforcement	Do within application Locally specified ACLs for non-corporate entities OAuth to share with other sites	Do within application XACML for policy specification from PAP OAuth to share with other sites	Do within application or externalize to web service gateway product.
9	Audit Logs	Log activity –	Log activity – encrypt with	Log activity – encrypt

		encrypt with time stamp	time stamp	with time stamp
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Software as a Service

Software as a Service offerings are at the vanguard of cloud services and the most likely to offer options beyond local registration, authentication and policy specification. The above sections will be most relevant to this type of service.

Platform as a Service

All of the access control considerations discussed above apply at least in theory to services within a PaaS environment; but PaaS services are newer and may not yet offer options beyond local registration, authentication, and access control.

PaaS customers should ask about the cloud service's ability to provide identity management services to the customers of the applications they create. PaaS customers can create their own identity management services using the advice given above. Alternatively, they can leverage identity services provided by the underlying cloud provider, but only if those underlying services support adequate partitioning of policy domains and secure delegated administration. A PaaS customer would need administrative access to specify policy for their application, but shouldn't be able to influence any other policy domain managed by that cloud identity service. This partitioning is necessary for policy specification, SPML and SAML (or similar) services to enable the cloud to receive requests on behalf of PaaS customers and route them to each customer's environment. PaaS customers should consider the identity needs of the services they intend to create and ask PaaS providers about how such needs can be met.

Infrastructure as a Service

All of the access control considerations discussed above apply theoretically to services within an IaaS environment, but IaaS services are less likely to be web-based and many of the solutions discussed above are web-enabled solutions. In most cases, an IaaS customer will receive access to a virtual machine and be responsible for configuring all aspects of the system. The access control advice discussed above applies to the applications that an IaaS customer sets up in their IaaS environment.

For efficiency, cloud providers prefer to automate the provisioning of pre-built images of operating systems and possibly higher level services such as databases and web servers onto virtual machines. Customers should ensure,

however, that the provider will customize the accounts and access management on a per-customer basis, so that the passwords and privileges given to one customer don't enable them to access other customer environments.

Questions for Your Provider and Assessment Checklist

General Questions

- What access control model is used and how well does it meet a customer requirements?
- Are the authoritative sources of access control policy and user profile information chosen by the cloud provider, the individual user, or a third party such as the organization a user belongs to?
- Where do user accounts reside, how are they provisioned and deprovisioned, and how is the integrity of the information protected?
- What authentication mechanisms are supported and are they appropriate for the sensitivity of the information in the service?
- What single sign-on model(s), if any, are supported, and who can select the external authentication services allowed for a particular user (which influences the integrity of data used for access control)?
- Do you support the ability to retrieve access control policy from external sources and if so, what formats and transmission mechanisms are accepted?
- Do you support retrieval of user profile information from external sources, and if so what formats and transmission mechanisms are accepted?
- What support is provided for delegated administration by policy administration services?
- What log information is provided, and can it be accessed in a manner that can be imported into internal corporate analysis and reporting tools?
- Can a user specify non-corporate entities with which to share information? If so, how is that accomplished?
- Can a user share his or her content at this service with their account at another service? If so, how is that accomplished, and is it done in an industry standard way?

Software as a Service

- Can a user choose to allow sharing of information with a select group of friends or trusted third parties?

Platform as a Service

- What kind of platform services are provided?
- Are any common application services such as databases, directories, and file systems provided; if so how are they provisioned, configured, accessed, and protected?
- How is one PaaS customer's environment protected from other customers?
- If common identity services are used, what capability is provided to segregate policy domains between PaaS customers and *their* customers?
- What delegated administration capability, if any, is provided to help PaaS customer manage identity and access management needs for their customers?
- What protection is provided for code in the PaaS environment?
- What protection is provided for moving code between development, test, and production environments?
- How are keys (for services such as SSH or SSL) generated, managed, and protected in dynamic environments? Who is responsible for key management?
- What capability is provided for PaaS customers to specify firewall rules, load balancer policy, name service entries, etc.?
- What capability and options are provided for PaaS customers to promote their creations to production cloud environments, and how much control is offered over capacity requirements such as disk space and CPU utilization?
- What access is provided to logs of activity within PaaS customer environments?

Infrastructure as a Service

- What kind of environment is provided (full host, virtual machine, logical domains, zone, or something else?)
- What service level agreement governs the amount of virtualized compute resource available and the speed with which it is provisioned after a request for more?
- What kinds of accounts and privileges are available in the provided environment?
- What mechanisms protect my environment from other IaaS customers?
- What access is provided to logs of activity influencing an IaaS customer's environment?

- Are any common application services such as databases, directories, or file systems provided and if so how are they provisioned, configured, accessed, and protected?
- How are keys for services such as SSH or SSL generated, managed, and protected in a dynamic environment? Who is responsible for key management?

Future Outlook

Software as a Service

SaaS services are still immature in terms of identity management support. The future will likely bring increased adoption of industry standard mechanisms such as SPML and XACML for externalization of policy and user profile management. In addition, the following services and standards may become important, and bear watching.

- **Attribute Provider services:** These may become more common in the future for attribute provider services.
- **eXtensible Resource Identifier (XRI):** Though not widely adopted for this purpose, this standard may become useful in the future for cross-domain references to resources.
- **eXtensible Resource Descriptor Sequence (XRDS):** Though not widely adopted for this purpose, this standard may become useful in the future for resource metadata.

Platform as a Service

PaaS services are quite rudimentary at this time with respect to identity management. The future will likely bring increased awareness among PaaS vendors of their customers' identity management requirements, and with that increased support for federation and externalization of policy and user profile management — or at least the ability to import such data from external sources.

Infrastructure as a Service

IaaS services typically support only local user and access management capabilities today. The future will likely bring larger customers to IaaS environments, and therefore more sophisticated requirements for both compute platform and user provisioning — including importing users and authorizations, delegated administration, and partitioning of access models within IaaS environments.

Cloud Identity as a Service (IDaaS)

Cloud Identity as a Service (IDaaS) is fundamentally the management of identities in the cloud, outside the applications (and possibly even the providers) that use them. The service is provided as third party management of identity and access control functions, including user life cycle management and single sign-on. The term is quite broad, and encompasses service for software, platform, or infrastructure services; and for both public and private clouds. Hybrid solutions are also possible, whereby identities can still be managed internally within an organization, while other components such as authentication are externalized through a Service Oriented Architecture (SOA). This effectively creates a Platform as a Service (PaaS) layer to facilitate a cloud-based IAM solution. If any portion of identity or access management functions is externalized to an IDaaS service, several challenges arise.

IDaaS: Security Challenges

The challenges for IDaaS are different not just from the perspective of the SPI (SaaS, PaaS, IaaS) but also depending on which type of identity is externalized to or managed within the cloud. The users to be managed by an IDaaS service may be either 'internal' to an organization (e.g., corporate users) or 'external' to an organization (e.g., users of a product or service the organization offers) or the users may not be associated with any organization at all and simply be consumers of a service. The challenges of each scenario are inherently different, and as a result impact different stakeholders within the organization, as often the "information owner" for 'internal' and 'external' identities are different and 'external' users may even exist across business units. The challenges that consumers face in having their identity serviced in a cloud environment are also very different, and raise issues of reputation that must be considered by both CSPs and consumers.

Issues and Challenges

SaaS

Customers wishing to use IDaaS with SaaS must consider how well IDaaS providers can manage the three different types of users described above, namely 'internal' users (employees of an enterprise), 'external' users (customers and partners), and lastly consumers who are acting on their own behalf. Consideration should also be given to requirements, if any, for IDaaS support for programmatic web services interaction. Customers need to consider, for each category of user, how well an IDaaS vendor supports the identity and access management requirements for provisioning, authentication, access control and

audit/compliance, preferably in an industry-standard manner.

Internal Users: When implementing IDaaS the security and privacy of employee information must be considered. Since users' identities are stored and processed by software in a publicly accessible infrastructure, it is possible that compromise of their identity could enable compromise of your internal systems. Therefore, consideration must be given to reducing risk factors to the extent practical. How is personal information securely transmitted and protected? How are passwords or any dual-factor login credentials securely provisioned, stored, and protected? And how is the Software Development Lifecycle (SDLC) of the product managed? All need to be compatible with organizational security policy. Consideration for non-physical access to user attributes including credential should be considered. It is also important to consider the security of administrative access, and possible additional protections, since the administrative interface may be accessible over the Internet.

External Users: Products and services offered to users who are not part of the corporate entity raise different challenges when externalizing IAM service to an IDaaS CSP. The IAM functions of the IDaaS solution will help determine what security is required in the client systems, and this is important to keep in mind through the product development lifecycle. When authentication to a service is outsourced to IDaaS, the IDaaS system takes over management and administration of user accounts. In this model, users will first authenticate to the cloud service and through the trusted interface you have set up with that vendor they will then access your service. As a consumer of cloud services, you are trusting that the vendor's policies, practices, and procedures will ensure that the identity of each authenticated user corresponds to the identity you trust in your product or service. A final important consideration is the value and location of information about 'external' users. Information about customers and partners is valuable, and provisions should be made so information is available to all functions of the organization that need it, such as marketing.

Consumers: Consumers of self-asserted authentication mechanisms such as Google, Facebook, Live ID, and Yahoo IDs should be able to sign in using existing credentials that need not be stored by the consuming site. OpenID is another option when the application is targeted outside enterprise users. However, when control of OpenID and other user-centric credentials is outside the enterprise, the privileges of such users should be limited appropriately. In this model consumers want to be confident that the privacy policy of their service provider is acceptable, but this alone is not enough. Identity as a consumer is becoming a commodity. Identity for consumers is more than just sensitive personal information (*i.e.*, Social Security Number). For consumers, identity is now also about reputation across feedback for auction items, social feeds, following friends, and professional recommendations. These may all have impacts on identity in the cloud. The protections applied to consumer identities

stored in the cloud affect both their own reputations and those of the enterprises that handle and make use of them.

PaaS

A PaaS customer that wishes to leverage an IDaaS solution to provide identity services for its application will have issues similar to those described above for SaaS customers, and may have additional concerns around web service interaction between their application and the IDaaS service. PaaS customers need to consider how identities are provisioned and deprovisioned, where identity information is stored, and how their PaaS application can access user identity information. PaaS customers also need to consider where authentication is performed, and if this is by the IDaaS provider, how information about authentication actions is securely transmitted to their applications. Lastly, PaaS customers may need to interact with the IDaaS provider for access control decisions, and if so need additional information to support audit functions. As much of this interaction will likely occur via web services, many traditional concerns about SOA environments will be applicable.

Transactional integrity across multiple SOA operations can raise audit issues. While providing interoperability, an SOA is not transactional across disparate interfaces. Depending on the implementation of the interface, transactions may not be tracked across operations or methods, even within an existing session. Therefore, to maintain auditability, some form of tracking routine must be considered to enable tracing transactions from start to finish. While this transaction integrity is a concern in other SPI types and with IAM in general, this decoupling brings additional issues.

IaaS

The top IDaaS challenges for IaaS center around the management of privileged access to virtual machines provisioned on an IaaS platform. Most of the IDaaS providers focus on managing user authentication (*e.g.*, single sign-on) for SaaS and PaaS platforms. A risk dimension to consider is virtual machine authenticity linked to user identity. When using a pre-configured image there are a number of outcomes, which may impact operations depending upon how and by whom the image was created. Images should not be trusted merely based on meta-information such as “creator” or “owner” of the image. Both image and user authenticity should be verified securely prior to deployment.

As we have seen, use of IDaaS services poses interesting challenges; based on the types of users and whether the IDaaS capability is used by SaaS, PaaS, or IaaS environments. The following section covers possible solutions for these various cases.

IDaaS: Solutions and Recommendations

Identity as a Service should follow the same best practices that an internal IAM implementation does, with added considerations for privacy, integrity, and auditability.

SaaS

Internal users: Custodians must review the cloud provider's options for providing secure access to the cloud, either through a direct VPN, or through an industry standard such as SAML and strong authentication. The reduction of cost using the cloud needs to be balanced with risk mitigation measures to address the privacy considerations inherent in having employee information stored externally, and on how the cloud provider is protecting that data (e.g., encryption of data at rest and in transit).

External users: Information owners for external users need to incorporate interactions with IAM providers into their SDLC, as well as into their threat assessments. Application security – the interactions of the various components with each other, and the vulnerabilities created thereby (such as SQL injection and Cross Site Scripting, among many others) – must also be considered and protections implemented.

Consumers: Consumers may not have a direct 'solution' for IAM implemented in the cloud in a SaaS model, but there are some recommendations to follow. Consumers must be concerned about the information they provide, and pay strict attention to the uses it may be put to. When entering data, they should continually ask, "Does this provider need this data"? If asked for sensitive data such as a Social Security Number or credit card number, they should determine why this data is needed, and lacking an adequate reason, they should cease providing data. In cases where this option is not practical, consumers should take the initiative to communicate with the provider and inquire about security and privacy measures, and make sure that the provider is aware of their responsibility to take such protections. Without consumer feedback, there will be significantly less incentive for providers to take appropriate measures.

PaaS

PaaS customers should research the extent to which an IDaaS vendor supports industry standards for provisioning, authentication, communication about access control policy, and audit information.

Proprietary solutions present a significant risk for components of your IAM environment in the cloud, because of their lack of transparency. Proprietary

network protocols, encryption algorithms, and data communication are often less secure, less robust, and less interoperable. It is important to use open standards for the components of IAM you are externalizing from your implementation. These must be followed in practice by the cloud provider, and used correctly. Examples include SSL and IPSec for network encryption, AES and Blowfish for encryption of data at risk, X.509 for Public Key Infrastructures, SAML and/or Kerberos for authentication, XACML for authorization, XDAS for distributed auditing, and SPML for provisioning. If open standards are not used, this should create a significant “red flag” for careful consideration before proceeding.

IaaS

Third-party images used for launching virtual servers need to be verified for user and image authenticity. A review of the support provided for life cycle management of the image must have the same principles as software installed on the network within your infrastructure.

IDaaS: Recommendations

- Use the cloud to create common service layers and leverage solutions from vendors, enabling removal of application silos without sacrificing existing information security policies and procedures.
- Keep all existing IAM practices in place with additional focus on privacy, integrity, and auditability when moving data off-site and/or decoupling the pillars of the solution into a web service architecture.

IDaaS: Questions for Your Provider and Assessment Checklist

- Please provide any documentation you have outlining the security architecture of this solution covering web services security, authentication, audit trails, user ID timestamps, etc.
- Please describe what protocols and options are available for single sign-on.
- Please provide your security administration manual or security portions of your system administration manual.
- Please describe user account and password controls and options.
- Please describe security reports available from your systems, and sample reports.
- Please provide a copy of your privacy policy.
- What standards do you support for federated identities, provisioning, distributing auditing, and cross-domain authorization?
- Do we have the option to make parts of your cloud private?

- What mechanisms protect against an employee of the IDaaS provider adding rogue accounts that give access to the customer's protected resources?
- What mechanisms protect against an employee using a valid account with excess privileges or accidental removal of correct privileges?
- Do you provide support for correlating identities across log files we receive from applications protected by your services, including when identities are federated and different at those applications?
- Do you provide mechanisms for protecting against outside parties correlating a user's activity across different providers?

IDaaS: Future Outlook

The cloud provides a number of benefits enabling reduced costs and project time to deliver solutions. IDaaS is a maturing part of this revolution, but this particular market is still quite early in its development. Some organizations, at the time of this writing, have staked their claim to managing identities in the cloud and externalizing the identities through web services. They often provide options for cloud and non-cloud (traditional) providers, so a viable solution can be put in place that meets your requirements. Cloud providers need to keep offering options between traditional Identity Management and Identity as a Service, while building maturity and filling the gaps. For users who make the jump cleanly to IDaaS, the responsibility to maintain the privacy and security of the sensitive data stored therein remains paramount.

For consumers the issue is the safety and security of their reputation and their identity; these may continue to blur. The time may never come where a consumer's negative feedback in an auction affects their ability to get a loan, but loss of external reputation (such as a credit score) via identity theft will continue to be a significant issue and consumers must be protected against this risk when their identities are maintained in the cloud.

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- OpenID: <http://openid.net>
- OATH: <http://www.openauthentication.org>

The Initiative for Open AuTHentication (OATH) is a collaboration of leading device, platform and application companies. OATH participants hope to foster use of strong authentication across networks, devices and applications. OATH participants work collectively to facilitate standards work and build a reference architecture for open authentication while evangelizing the benefits of strong interoperable authentication in a networked world.

- SAML: <http://www.oasis-open.org/specs/index.php#saml>
- WS-Federation: <http://docs.oasis-open.org/wsfed/federation/v1.2/os/ws-federation-1.2-spec-os.html>

Attribute Exchange: User-Centric

OpenID attribute exchange: http://openid.net/specs/openid-attribute-exchange-1_0.html

OAuth (created by a small group of individuals): <http://OAuth.net/>

Windows CardSpace: <http://msdn.microsoft.com/en-us/library/aa480189.aspx>

OpenSocial: sharing social networking information <http://www.opensocial.org/>

Authorization

XACML: http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=xacml

IDaaS

- <http://blogs.forrester.com/srm/2007/08/two-faces-of-id.html>
- <http://www.aspeninstitute.org/publications/identity-age-cloud-computing-next-generation-internets-impact-business-governance-social>
- <http://blog.odysen.com/2009/06/security-and-identity-as-service-idaas.html>