



[www.internet2.edu](http://www.internet2.edu)

Middleware is a layer of software between a network and the applications that use it. Middleware is used both to find people and things, as with directory services, and to keep them hidden, as with security services.

## Middleware

<http://middleware.internet2.edu/>

The Internet2 Middleware Initiative (I2-MI) concerns itself with five interrelated and overlapping areas of core middleware:

**Directories** enable users and applications to find information ("attributes") about people and things ("entities"). Directories are the hub of Internet2 middleware.

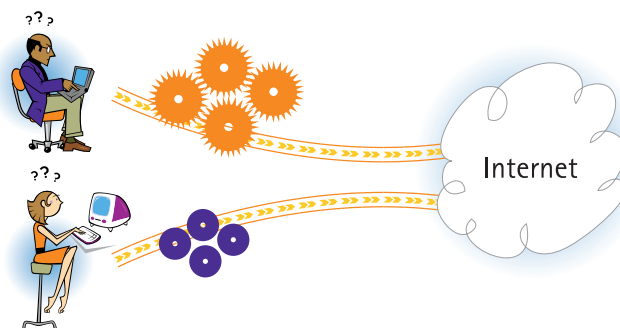
**Identifiers** are labels for entities. Interoperable, consistently administered sets of identifiers are necessary to deal with the enormous numbers of entities of many different kinds found on the Internet. Giving users control over their identifiers is at the heart of the problem of ensuring privacy.

**Authentication** is the process of verifying that the use of an identifier is valid. Typically authentication is done by a user presenting a password, smartcard, or electronic credential.

**Authorization** is the process of deciding what an authenticated entity is allowed to do. For example, being a member of a campus community might permit a user to access a digital library; being a departmental staff person might permit a user to commit resources and hire people; being a member of a scientific workgroup might permit a user to control a remote scientific instrument.

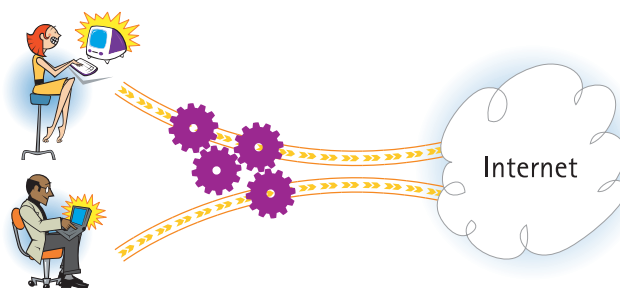
**Public Key Infrastructure (PKI)** is a very promising but complex and hard-to-implement set of techniques for electronic security. PKI is based on the exchange of electronic credentials called certificates; certificates are stored in directories, contain identifiers, and are used for authentication and authorization.

### Without Middleware



much duplication of effort, heavy administrative burden, little interoperability

### With Middleware



no duplication of effort, lighter administrative burden, more interoperability

The absence of common middleware solutions is a big problem for today's research and education networks. Applications either make do without middleware functions, in which case usability and efficiency suffer, or applications perform middleware functions themselves, which leads to competing and incompatible standards. In coordination with other middleware-oriented efforts—most importantly via the NSF Middleware Initiative ([www.nsf-middleware.org](http://www.nsf-middleware.org))—I2-MI is working toward the deployment of interoperable core middleware services at Internet2 universities.