

Recent Developments in Middleware Standardization for Mobile Computing

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When a newcomer tries to find out relevant standardization forums of mobile middleware, he soon finds out to be in a jungle of forums. He faces a bunch of acronyms like IETF, 3GPP, 3GPP2, WWRF, OMG, OMA, W3C, WS-I, FIPA, JCP, DLNA, TCG, OSGi, UDDI, OASIS, UPnP Forum, Liberty Alliance. The tutorial gives a map of standardization activities relevant to mobile middleware.

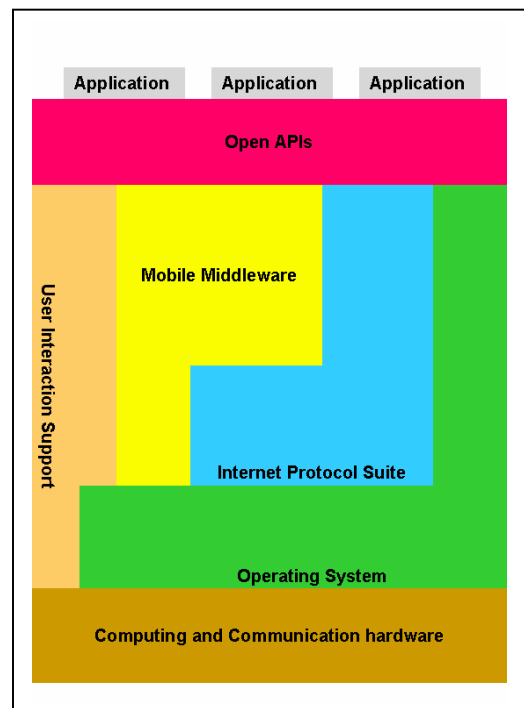
The attached figure outlines the software architecture of a solution stack. The primary constituents are Operating System, Internet Protocol Suite, Mobile Middleware, and User Interaction Support. An application obtains the services of these entities through common Application Programming Interfaces (APIs). If the applications would be stand-alone, then only Open APIs need to be standardized. However, most of the applications in the wireless world are networked and/or distributed. Therefore, we also need standard protocols that the applications use in their interactions. We also need standardization in mobile middleware, since generic service elements interact with generic service elements in other hosts. For us mobile middleware consists of an execution environment and a set of generic service elements like discovery and event notification.

Most of the standard protocols become from the *Internet Engineering Tasks Force* (IETF). The situation in generic service elements is much more confusing, since there are tens of forums that specify competing and complementing middleware services.

The IETF is a huge open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual. The actual technical work of the IETF is done in its working groups, which are organized by topic in several areas. The challenge is how the numerous Internet protocols are incorporated to the middleware.

In addition to IETF (<http://www.ietf.org/>) there are several forums that a mobile middleware researcher/developer needs to be aware. *Third Generation Partnership Project* (3GPP; <http://www.3gpp.org/>) and *Third Generation Partnership Project 2* (3GPP2; <http://www.3gpp2.org/>) are forums that specify 3rd generation mobile telephony systems. From middleware perspective they do not create anything new, which is a good piece of news, but select existing standardized solutions like a set of Internet protocols and *Parlay* (<http://www.parlay.org/>) Open Service Architecture. The *Wireless World Research Forum* (WWRF; <http://www.wireless-world-research.org/>) is a prestandardization forum addressing issues related to the 4G or Beyond 3G Systems.

Object Management Group (OMG; <http://www.omg.org/>) is the forum specifying CORBA and its extensions, and UML. In the CORBA realm, there are not very much going on related to mobile middleware. Recent specifications of Wireless CORBA (OMG document: formal/2003-03-64), Super Distributed Objects (OMG document: dtc/2003-04-02) and Smart Transducers (OMG document: formal/2003-01-01) are useful in wireless environments. The Model Driven Architecture (MDA; <http://www.omg.org/mda/>) may be the next silver bullet in software development, also for the wireless world. In MDA the target is to raise the abstraction level of software development: modelling instead of programming. The essence is code generation directly from the specification.



Open Mobile Alliance (OMA; <http://www.openmobilealliance.org/>) specifies service enablers for the mobile world. The core of OMA work is inherited from the forums (SyncML initiative, Wireless Village, Location Interoperability Forum - LIF, WAP Forum, Mobile Wireless Internet Forum - MWIF, and Mobile Gaming Interoperability Forum - MGIF) that merged into OMA.

World Wide Web Consortium (W3C; <http://www.w3.org/>) has several activities that are relevant to wireless world. These include Web Services Activity, Device Independence Activity, and Semantic Web Activity. In the Web Services Activity, there are working groups for Web Services Architecture, XML Protocol (SOAP), Web Services Description, and Web Services Choreography. The Device Independence Activity has recently published Device Independence Principles. There is also the document CC/PP¹: Structure and Vocabularies. In the Semantic Web Activity, there are RDF Core Working Group and Web Ontology Working Group.

Some aspects of service description are also addressed in **Organization for the Advancement of Structured Information Standards** (OASIS; <http://www.oasis-open.org/>), particularly in Universal Description, Discovery and Integration (UDDI; <http://www.uddi.org/>). **Foundation of Intelligent Physical Agents** (FIPA; <http://www.fipa.org/>) has Networking Ontology specification that provides the means to describe properties of connectivity. FIPA has also developed Device Ontology Specification.

Java Community Process (JCP; <http://jcp.org/>) has recently produced several JSRs increasing the functionality of Java 2 Micro Edition (J2ME). The primary targets of **Open Services Gateway Initiative** (OSGi; <http://www.osgi.org/>) specification are digital and analog set top boxes, service gateways, cable modems, consumer electronics, PC s, industrial computers, cars and more.

The **Liberty Alliance Project** (<http://www.liberty-project.org/>) has the mission of serving as the premier open alliance for federated network identity management and services. It ensures interoperability, supports privacy and promotes adoption of its specifications, guidelines and best practices. Liberty Alliance Version 1.1 Specification Suite incorporated Federated Authentication to enable seamless sign-on. Liberty Alliance Version 2.0 Specification Suite will feature Web Service Framework, authorizing e.g. a Service Provider to access your location information.

In addition, there are also **UPnP™ Forum** (<http://www.upnp.org/>) addressing discovery and autoconfiguration, **Web Services Interoperability Organization** (WS-I; <http://www.ws-i.org/>) promoting Web Services Interoperability across platforms, operating systems and programming languages, **Trusted Computing Group** (TCG; <https://www.trustedcomputinggroup.org/home>) specifying security in the network layer, and **Digital Living Network Alliance** (DLNA; <http://www.dlna.org/>) ensuring interoperability of consumer electronics, personal computers and mobile devices in the home.

To conclude, the standardization landscape is quite a mesh. The IETF covers the Internet Protocol Suite but has a vast number of working groups. The middleware services are standardized here and there including tens of forums. The major forums for wireless world seem to be Open Mobile Alliance, W3C, and Liberty Alliance.

¹ Composite Capabilities/ Preference Profile