Geographic Information Systems for the Java™ Platform

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Geographic Information Systems for the Java Platform

An ESRI White Paper

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Geographic Information Systems for the Java Platform

Why the Java Platform

The Java™ platform is a new way of computing based on the power of networks and the idea that the same software should run on different platforms, whether locally on a computer, over the Internet, or on any other machine including smart devices. Java is able to do this because it

- Is simple yet robust, with small footprint, ideal for rapid prototyping and development
- Is platform independent (write once, run anywhere)
- Has high performance, multithreaded design
- Is object oriented, producing reusable object-oriented components
- Is network oriented, easily dealing with protocols such as HTTP and FTP

These features make Java the preferred Internet and enterprise computing platform for developers and information technology professionals.

Java's open, platform-independent, object-oriented design is an ideal platform for ESRI's mapping and geographic information system (GIS) solutions for developers.

What Is GIS

ESRI® software links geographic information (where things are) with descriptive information (what things are like). A GIS represents data as maps made up of layers describing different types of data with infinite layers of information.

ESRI's software is able to read the map layers and quickly answer questions such as

- What is this feature?
- What buildings are near the road?
- What is the fastest route to dispatch crews to an emergency location?
- How many customer types live in a given census tract?
- Which parcels are zoned commercial and which are vacant?

Most organizations' databases already contain spatial information that is not being used. GIS takes the information and integrates it for visual display so that users can see

- Customer addresses and postal codes
- Store locations and customer proximity
- Routes between stores, factories, and warehouses
- The location of assets such as telephone poles and electric transformers
- Routes for deliveries and service calls

Whether maintaining store revenues, equipment locations, customer data, or facilities information in a database management system (DBMS), GIS can add insight to help make better decisions.

Why GIS for the Java Developer

ESRI opens the world of GIS and mapping to the Java developer. The Java platform's hardware independent and network-oriented design allows developers to enjoy ESRI's tools across multiple platforms, providing end users with a wide range of interactive mapping capabilities.

ESRI's Java solutions cover a wide range of needs for both developers and end users. They include lightweight desktop applications, Java application programming interfaces (APIs) for accessing spatial databases, components for creating new Java-based applications or embedding GIS capabilities into existing Java applications, and Java technology to implement Web mapping and GIS solutions. Whether creating Web, stand-alone, or enterprise solutions, ESRI's Java technology provides a solution.

This paper briefly describes the various ways that ESRI technology provides opportunities for Java development and integration. The relationship among these components of ESRI's Java strategy is summarized in the following diagram.

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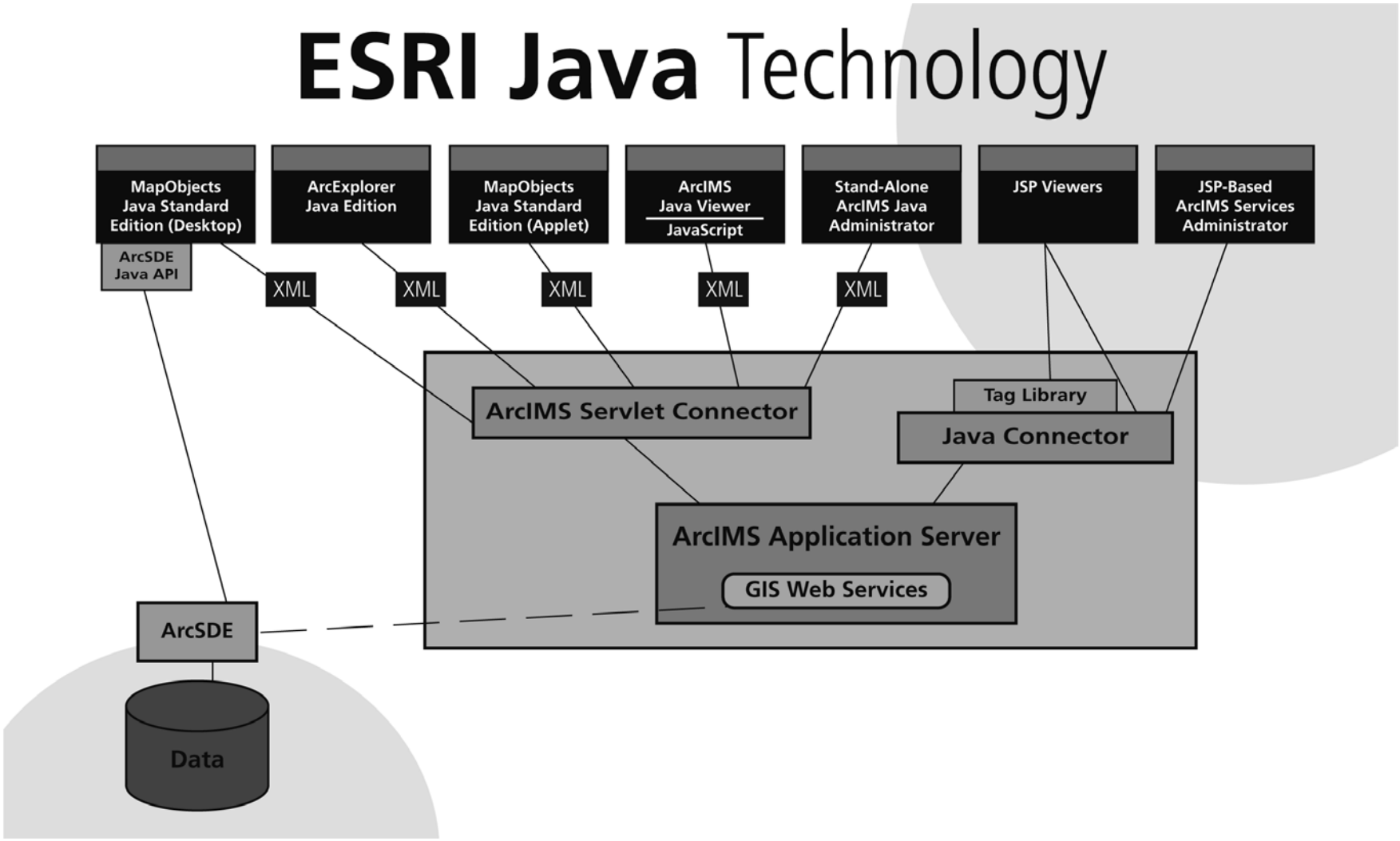

ESRI Java Technology
MapObjects Java Standard Edition (Desktop)
ArcExplorer Java Edition
MapObjects Java Standard Edition (Applet)
ArcIMS Java Viewer
JavaScript
Stand-Alone ArcIMS Java Administrator
JSP Viewers
JSP-Based ArcIMS Services Administrator
ArcSDE Java API
XML
XML
XML
XML
XML
ArcIMS Servlet Connector
Tag Library
Java Connector
ArcIMS Application Server
GIS Web Services
ArcSDE
Data

GIS Tools for Java Developers

ESRI's tools for Java developers build upon the Java platform's ease of development and widespread industry support.

MapObjects—Java Standard Edition

ESRI's clientside Java solution is MapObjects®—Java Standard Edition. This pure Java API allows developers to build cross-platform custom clients or easily integrate mapping and GIS into existing Java applications. MapObjects is a a suite of embeddable mapping components available as pure Java components. MapObjects can be used to build powerful client and desktop applications or add GIS capabilities to existing applications. These capabilities include a wide range of map display, geographic query, and data retrieval activities.

MapObjects—Java Standard Edition allows users to create applications that perform activities such as labeling map features, thematic mapping, panning and zooming through multiple map layers, querying spatial and attribute data, performing geometric operations, measuring distances, displaying real-time geographic data, and much more.

MapObjects—Java Standard Edition is built entirely on the Java 2 platform. It consists of a set of Java Archive (JAR) files containing pure Java components that can be referenced and used to develop custom Java-based client stand-alone applications or applets.

The suite of visual JavaBeans™ contained in MapObjects—Java Standard Edition can be referenced in an integrated development environment (IDE) such as JBuilder™ and Forte™ for Java. These beans can be used in a drag-and-drop environment for building graphical user interfaces.

All of the visual components in MapObjects—Java Standard Edition extend from the Java Swing components. Using these components, developers can build applications that include functional toolbars, overview maps, and map legends that make custom applications easy to use.

The software comes with Javadoc (standard interface and class descriptions), a programmer's reference, a guide to building applications, more than 20 sample applications (including source code), quick-start tutorials, and a comprehensive object model diagram.

ESRI Technology in Action: ArcExplorer—Java Edition

An example of a client application created with MapObjects—Java Standard Edition is ESRI's ArcExplorer™—Java Edition. ArcExplorer—Java Edition is a lightweight GIS data viewer developed by ESRI. This freely available software offers an easy way to perform basic GIS functions including display, query, and data retrieval. It can be used on its own with local data sets or as a client to Internet data and map servers. Because ArcExplorer—Java Edition is based on the Java platform, users can enjoy cross-platform support. Between 4,000 and 8,000 downloads of this software are executed each month from the ESRI Web site.

ArcExplorer Case Study—Illinois State Police

Illinois State Police (ISP) has primary enforcement responsibilities for the entire interstate highway system within Illinois as well as the Chicago expressways. The ISP warehouses up to 75,000 crash reports handled by its officers including those that occur in the city of Chicago. When ISP began using ESRI software in 1994, GIS was utilized by three of its employees; today, a majority of its researchers and analytical personnel use GIS in various degrees.

ISP has published its GIS files on CD–ROM for use with ArcExplorer to create maps for enforcement officers. ArcExplorer is loaded on the computers of patrol lieutenants and master sergeants in several of its state police districts. This saves ISP invaluable time and effort, as the maps are easily published and distributed for each district.

ArcExplorer is helping ISP give district personnel the ability to analyze information more quickly and thoroughly within their Intranet. Questions such as "Where are our enforcement resources in relationship to traffic fatality locations?" can now be asked and answered with the click of a few buttons. Browser-based ArcExplorer is used to ask these types of questions. Internal users can also access crash data by township, county, and state from the ISP Web site.

ISP recently purchased 1,000 mobile data computers (MDCs) for use in squad cars in the field.

ArcExplorer has met the needs of the users at ISP. According to its GIS manager, "As for training, starting with the Internet browser, anyone is able to use ArcExplorer. All I need is just a simple query, simple click of a mouse to zoom in and out, and a few frame windows. Anyone can do it regardless of what kind of background they have in using computers and applications."

GIS for the Java Platform Over the Internet

The Internet makes sense for organizations centralizing the maintenance of software services and data. Using the Internet, software can be easily updated, and users can gain access to the applications and information they need for specific tasks.

As businesses have found, the Internet does not change the nature of an application or its usefulness; it delivers it online and makes it available to more users. Now, ESRI makes it easy for businesses to disseminate GIS data and applications over the Internet, making it more cost-effective and easily managed.

ESRI brings GIS on the Internet to its clients through both serverside GIS and client/browser connections.

ArcIMS

ESRI's ArcIMS® software provides the foundation for distributing high-end mapping, GIS, and services over the Internet. ArcIMS is designed to make it easy to create map services, develop Web pages for communicating with the map services, and administer sites. It enables users to integrate local data sources with Internet data sources for display, query, and analysis in an easy-to-use Web browser. ArcIMS uses Java-based components that communicate with and access these ArcIMS services.

The ArcIMS Application Server Connectors connect the Web server to the ArcIMS Application Server. The ArcIMS Servlet Connector is the standard connector used with ArcIMS. It supports the Open GIS Consortium Web Map Services (WMS) 1.1 implementation specification.

ArcIMS also comes with a Java Connector, which allows developers to program Java clients and Java applications that use a set of JavaBeans. The Java Connector communicates with the ArcIMS Application Server via a JavaServer Pages (JSP) client or a stand-alone Java application. It is a reusable software component suite that includes a JavaBeans Object Model Library and a rich set of custom JSP tags supported in the form of a Tag Library. These JavaBeans and JSP tags allow developers to programmatically establish communication with an ArcIMS Application Server—via an HTTP, HTTPS, or

TCP/IP connection—and begin sending requests to it. Once the Application Server receives the request, it processes it and returns the appropriate response. With that response, the application can react accordingly.

On the client side, ArcIMS comes with a Java Viewer, which is a browser that uses a Java 2 applet for user interface components such as ArcIMS Spatial Server. The ArcIMS Java Viewer allows clientside drawing and editing and requires a Java plug-in. Java Viewers can be used with Feature or Image MapServices.

The ArcIMS Java Viewer can be customized using JavaScript to access methods and properties in the Java Viewer Object Model. The look and feel of ArcIMS Java Viewer can be customized using HTML and JavaScript to alter tags and parameters. Other Java technology that is part of the ArcIMS framework includes

- ArcIMS Administration—ArcIMS Web sites can be administered through the stand-alone Java Administrator or an administrator using a JSP implementation. The stand-alone Java Administrator is a desktop application that communicates using HTTP to administer an ArcIMS site. It administers the site using the Servlet Connector. The JSP Administrator is a Web application that administers an ArcIMS site using the Java Connector.

- JSP Viewer—a customizable and extensible Web application that uses the Java Connector.

GIS Web Services

GIS Web Services are self-contained, modular components and applications that can be published and accessed over the Web. They typically perform a specific GIS function that can be integrated as part of a larger application. ESRI's GIS Web services, known as ArcWeb℠ Services, let developers quickly integrate functionality into their applications without having to build or host the functionality locally, often resulting in significant savings of time, money, and disk space.

ArcWeb Services can be accessed from any Web-enabled application. This includes desktop applications as well as Web applications that are commonly built with Java or Active Server Pages (ASP). If the application can connect to the Web, a developer can integrate ArcWeb Services from ESRI.

ESRI's ArcWeb Services are deployed through standard Web protocols including HTTP and XML. They use the XML-based Simple Object Access Protocol (SOAP) to communicate, so they are compatible with the Java platform.

ESRI's GIS for Java in Action: Telemorphic, Inc., and the David Rumsey Map Collection

Telemorphic, Inc., is a leading innovator in Web-based mapping products and services. The company's core domain expertise in remote sensing and GIS applications, as well as Internet GIS application development, enabled the foundation to develop cutting-edge Web mapping products that provide seamless integration of image processing and visualization tools with enhanced GIS technologies.

Telemorphic's Maplicity is a lightweight Java applet designed to work with ESRI's ArcIMS, specifically its Image Map Services. Maplicity provides an easy-to-deploy, feature-rich interface for use over the Internet. Since Maplicity is written entirely in Java, it is compatible with any Web browser that supports the Java plug-in.

Users who wish to customize Maplicity can license MaplicitySDK. MaplicitySDK is the complete set of Java libraries for creating powerful Internet GIS and image processing applets and applications for ESRI's ArcIMS. MaplicitySDK is designed so developers can easily build and deploy custom Internet GIS solutions with any subset or all of the Maplicity functionality. MaplicitySDK includes more than 100 Java classes, Javadoc, user's guide, and source code for the Maplicity applets.

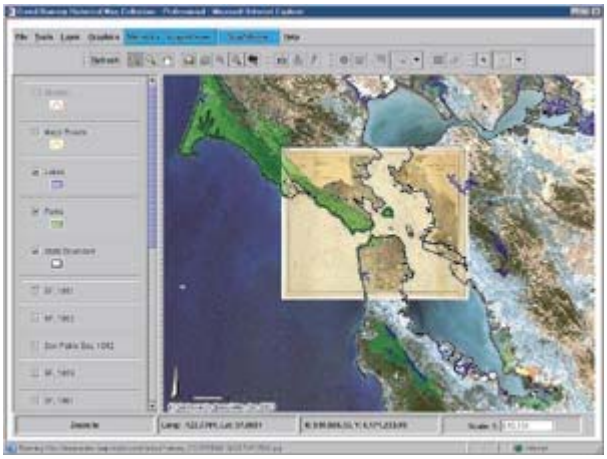
Maplicity in Action

See Telemorphic's Maplicity in action by visiting Cartography Associates' David Rumsey Map Collection. Cartography Associates, founded in 1996, promotes the distribution of digital facsimiles both in print and electronic media. The David Rumsey Historical Map Collection is a treasure of more than 6,400 maps online and focuses on rare eighteenth and nineteenth century North and South American cartographic history materials.

The David Rumsey Collection began almost two decades ago. Computerizing the collection began in 1997. Allowing viewers to zoom in and enlarge images on a computer screen would enable them to view more easily the vast amounts of detailed data included in many maps. The Internet allows anyone to access these rare maps and collections without damaging these valuable documents.

Presenting individual maps in digital format literally breaks the boundaries of an atlas's bookbinding, allowing the viewer to see single maps outside of their original bindings. This site allows users to see multiple maps from different time periods side by side. Going a step further, users can create their own collection of maps by saving groups of images that hold particular interest. This collection includes extensively cataloged data for each image for in-depth exploration.

This collection was given a GIS browser online using ESRI's ArcIMS software and Telemorphic's Maplicity and MapImager GIS software. Telemorphic's GIS browser at the site allows integration and interaction of historical maps with current geospatial data and other historical maps. Examination of the maps in the GIS reveals changes in the history of the areas shown on the maps.



Maplicity Powered David Rumsey Collection GIS Viewer for ArcIMS

Eleven historical maps of the San Francisco Bay area from 1851 to 1926 and 18 historical maps of the Boston area from 1776 through 1897 from the collection are now available for viewing in the Maplicity-based GIS browser. Additional historical maps of U.S.

cities, including Washington, New York, Los Angeles, Chicago, Denver, and Seattle, will be added in the near future.

The current geospatial data that can be overlaid and compared to the historical maps includes roads, lakes, parks, state boundaries, digital orthophotos (aerial photography), topographic map sheets, digital elevation models, and satellite imagery.

Managing Spatial Data on the Java Platform

Spatial data requires software to manage it, just as descriptive data does. ESRI's state-of-the-art solution is ArcSDE®—Spatial Database Engine™. It is gateway software that facilitates managing spatial data in commercial database management systems including IBM® DB2®, Informix®, Microsoft® SQL Server™, and Oracle®. The ability to manage spatial data alongside descriptive data in this manner is extremely useful. Companies do not need to invest in additional software or learn new software.

ArcSDE allows spatial data to be directly maintained in the format of the spatial types supported by each DBMS vendor—building on their parallel efforts to develop spatial extensions. While the spatial data is maintained in the DBMS-specific format, ArcSDE provides not only the business logic software for creating simple geometric data but also technology for supporting advanced spatial data types such as images, networks, features with integrated topology, and shared geometry. ArcSDE associates each spatial data type with these business rules, behavior, and other object properties.

ArcSDE also provides the infrastructure required to manage multiple users editing the same spatial database with long transactions, alternate versions, and history.

ArcSDE for Java API

ArcSDE has a Java API that gives developers the ability to create platform-independent client applications. The Java API supports ESRI's efforts in creating ArcExplorer—Java Edition, ArcIMS clients, MapObjects—Java Standard Edition, and additional ArcSDE clients. All these client applications—ArcExplorer, ArcIMS, and MapObjects—are all ArcSDE clients. This is exciting groundwork for future ESRI Java developments.

The ArcSDE for Java API can be used with Java Database Connectivity (JDBC) to work directly with the various databases. It is partially written in Java, still using some C functionality through the Java Native Interface (JNI).

The ArcSDE Java API allows developers to do many things. A developer can create ArcSDE client applications that run in a Web browser (Java applets). Java applications that manage a versioned database and JDBC applications that work directly with databases can also be created.

Conclusion

The Java platform allows developers and business users to create exact applications that run over networks and are platform independent. This suits GIS users and developers since it allows many users to access large amounts of data through computer networks or the Internet. Small footprint applications that are easy to use can be created, saving money and resources.

ESRI has created a family of GIS products for the Java platform. These products provide all the functionality a GIS user needs including managing large spatial databases, accessing those databases over networks including the Internet, and creating applications that allow users to see and manipulate the spatial data. ESRI provides a cradle-to-grave solution for users needing GIS functionality at their organization.

For more than 30 years ESRI has been helping people manage and analyze geographic information. ESRI offers a framework for implementing GIS technology in any organization with a seamless link from personal GIS on the desktop to enterprisewide GIS client/server and data management systems. ESRI GIS solutions are flexible and can be customized to meet the needs of our users. ESRI is a full-service GIS company, ready to help you begin, grow, and build success with GIS.

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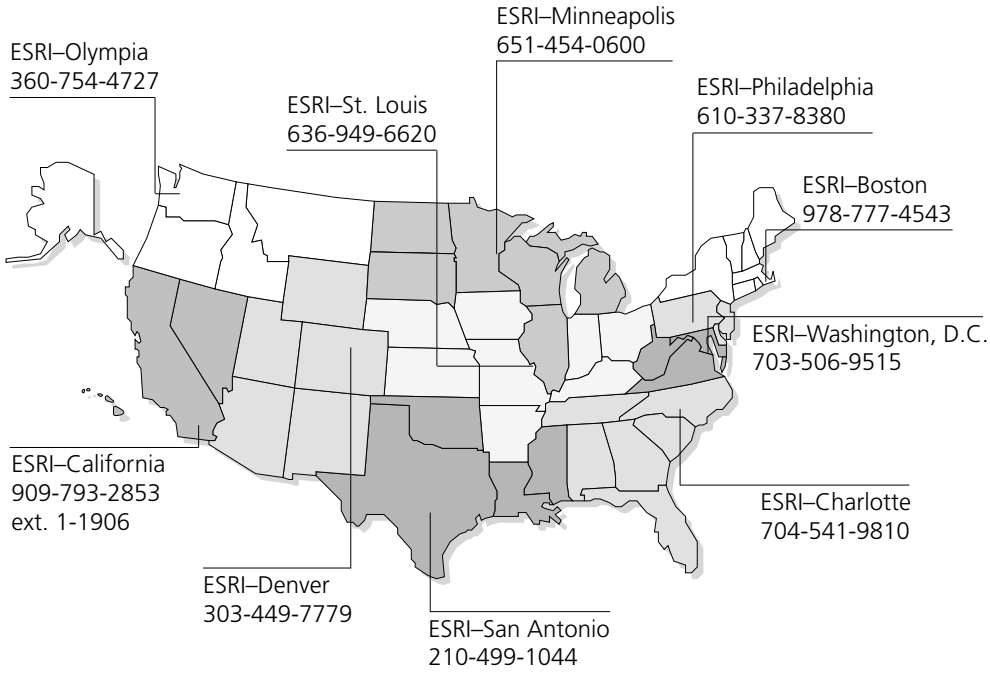

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