

autodesk

White Paper

**Autodesk[®] LocationLogic:
A Technical View**

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Audience

This paper provides a detailed technical perspective on the Autodesk® LocationLogic platform. It is intended for professional IT and engineering staff at wireless carriers and network operators that are interested in deploying location-based services, as well as application developers.

Autodesk LocationLogic Overview

Adding the element of subscriber location to existing wireless data applications, or offering new location-based applications, allows wireless carriers to significantly increase the quality and utility of information delivered to subscribers. Providing geographic context to personalized information services increases the value of the services to subscribers, and provides wireless carriers with new revenue opportunities.

A technology platform for deploying world-class location-based services requires far more than simply determining subscriber location. There are many additional technology components and considerations required to reach this goal, including:

- The ability to perform and manage location determination and spatial data processing in an integrated, highly available, reliable, scalable, and carrier-grade system
- Provision of a single integration point and common access interface to a variety of network positioning technologies
- Support for open standards that allow for ease of deployment and flexible integration with existing applications
- Provision of a content framework so that developers of location-based services can integrate and access global spatial data sets of street network and point of interest data
- The ability to enhance and refine location information with sophisticated geo-services functionality, including generating and calculating multi-mode routes, step-by-step directions, mapping, spatial searching, location refinement, and more
- The ability to seamlessly integrate with various network applications such as systems administration, billing, logging and reporting
- Support for a simplified, standards-based, extensible application programming interface for building personalized location-based services and applications

These and other key requirements can be achieved by employing a location-based services solution built with Autodesk LocationLogic. To explain how Autodesk LocationLogic can power customer-specific location-enabled applications and services, this introduction provides a high-level overview of the LocationLogic platform, and directs readers to online documentation that serve as detailed guides to designing, developing and deploying, and managing custom LocationLogic applications.

What is Autodesk LocationLogic?

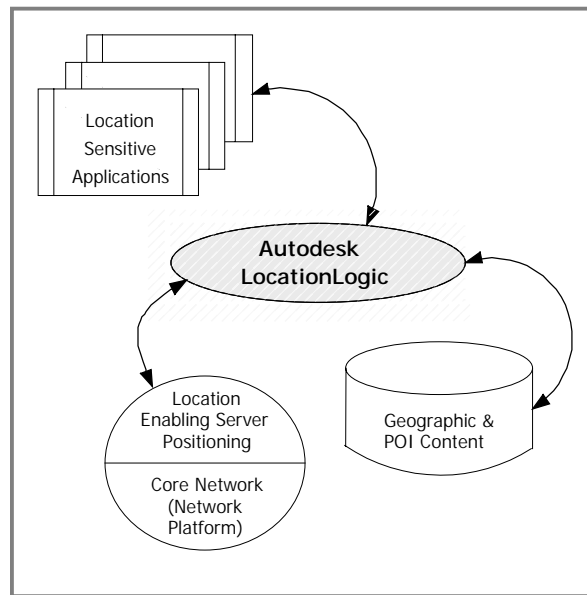
Autodesk LocationLogic provides a proven platform for wireless carriers and operators that plan to develop and host customized location-based services. LocationLogic provides the network connectivity, location determination technology (LDT) integration, geo-services functionality, and tools to deploy reliable, high performance applications. These applications deliver personalized, location-relevant information to end users of wired and wireless devices.

LocationLogic includes:

- The LocationLogic platform: A location-based application platform specially designed for deploying and managing location-based services and applications.
- The LocationLogic API: A Java-based API used for integrating existing or newly developed location-sensitive applications with the Autodesk LocationLogic platform

Powering Integrated Solutions

LocationLogic plays a central role in combining carrier network, location determination infrastructure, and geographic content with location-sensitive applications.



Carriers can extend the Autodesk LocationLogic platform by:

- Building and deploying their own, unique LBS applications
- Adding location to existing applications
- Licensing partner applications from Autodesk

The LocationLogic Platform

Deployed with a J2EE (Java 2 Enterprise Edition) application server, LocationLogic is implemented as a set of server-side application components, and the various tools used to administer and maintain them. These components are used to determine a mobile user's current location, compute optimized travel directions, generate device-appropriate maps, and search for location-aware information, such as advertisements or city guides.

A content database internal to the platform is used for maintaining street network data, Points of Interest (POI) and geocoding information at global scales. This database is used to manage and store unique subscriber information, such as current location, location history, location bookmarks and other location-relevant personal data. In addition, a data-bridging technology provides applications with a seamless, direct link to location-relevant personal data stored in external systems.

LocationLogic functionality is made available to location-based applications as a set of services accessible through a robust, fine-grained Java API (Application Programming Interface) and through a remote, coarser-grained SOAP/XML API.

LocationLogic Provides:

- A high performance environment for hosting location-based applications
- A common interface to a variety of location determination technologies
- Connectivity to external systems
- Access to global content
- Geographic mapping services
- Routing planning services
- Navigation and directions
- Location refinement and proximity searching
- Content searching services
- Geocoding services
- User Management
- Personal data management
- Mobile user object tracking
- Systems Administration
- Logging and reporting and more

Some of the key features and benefits of the Autodesk LocationLogic platform are described in the following sections.

Overview of Location-Enabling Services

LocationLogic offers a comprehensive set of location-enabling services for building location-based applications (a more detailed description of these services can be found the Architecture section of this document).

Location Determination - The ability to locate one or many subscribers.

Location Refinement - The ability to refine location through heuristics that calculate a list of probable locations near or within a region returned by the LDT. Probable locations can be compared against locations book-marked by the user, a user's location history (including previously calculated routes), points of interest and nearest links to underlying street networks.

Spatial Query - The location-sensitive retrieval of information based on spatial or temporal proximity to a position, region, or route.

Content Searching - Navigation and query of a hierarchy of categorized information sourced from the LocationLogic content store.

Geocoding - Simultaneous support for forward and reverse geocoding queries and interaction with third-party geocoding engines via a geocoding adapter architecture.

Mapping - Deliver device-independent B&W and color maps (png, bmp, wbmp). Support for highlighted route display, POIs, custom symbology, map size control and more.

Routing and Directions - Generation of route maps and step-by-step directions for multiple travel modes. "Best" routes are determined using shortest distance or time. Best route calculation between two or more locations. Support for both automotive (with or without traffic) and pedestrian travel modes. Directions are sent to the subscriber via SMS or e-mail.

Location Profiling - Storage and management of a user's location-specific profile, including location bookmarks, personal location history and travel preferences.

Scalability and Performance

Implemented with an application server in a multi-tiered, distributed environment, LocationLogic scales beyond hundreds, thousands, and even tens of thousands of application users. LocationLogic is designed for server and load optimization to achieve maximum performance based on test results measuring throughput, average response time and CPU utilization. The platform also takes advantage of high performance systems design concepts such as dynamic component distribution, for flexibility and scaling power.

LocationLogic's technology and design enables system capacity planning so that configurations can be optimized for any market size. Autodesk Location Services systems analysts can assist in designing and recommending an appropriate production system configuration.

Security and Privacy

The Autodesk LocationLogic solution is designed to meet carriers' stringent requirements for user privacy and system security.

The LocationLogic architecture leverages standard operating system, database, and Internet security mechanisms, including OS authentication, Oracle security mechanisms, and data encryption technologies (such as SSL and Sun Secure Hash Algorithms) to ensure that any access to, or data movement through, the platform is secure.

LocationLogic also supports carrier requirements for Privacy Assurance Management, implementing the administrative, technical and physical steps to pre-empt threats to the security and integrity of a subscriber's location information and personal profile.

LocationLogic supports a variety of end-user location privacy models, including opt-in, opt-out (requiring that a subscriber must provide consent, or "opt-in," for a service prior to being located) and password protection. This offers carriers the flexibility to protect user information without sacrificing application usability.

LocationLogic supports subscriber anonymity. LocationLogic can provide its services without knowing the real identity of the subscriber, protecting the user's privacy.

Availability & Reliability

Implemented within a distributed application architecture, Autodesk LocationLogic is designed to meet rigorous requirements for availability and reliability—minimizing unplanned service downtime.

Systems are custom-configured to achieve the desired level of availability through load balancing, clustering and fail over.

Designed with redundancy throughout the system, LocationLogic can assure that no single point of failure exists in a deployed system. LocationLogic takes advantage of fault management and recovery mechanisms to protect applications from client, server system or network failures.

Autodesk LocationLogic also provides administration tools and logging infrastructure to assist in monitoring status and availability of individual platform components, and in generating various performance reports.

Interoperability

Location applications need to inter-operate with many devices, legacy systems and data stores, as well as with a variety of network technologies and third-party content providers.

LocationLogic provides simple integration interfaces to external systems. It ensures that areas of interoperability are addressed intelligently, achieving a high degree of integration capability for data services and consumers, and easy access to external systems.

LocationLogic employs an architecture that abstracts elements from location applications, such as consumer device, various network and content components and external systems, maintaining the interoperability and flexibility required for dynamic system elements.

Mobile Devices

As the LBS market evolves, so too will the devices and infrastructure used to access information. LocationLogic has been built to interface with multiple devices and delivery channels to deliver location-based information that is appropriate for any end-user device.

LocationLogic supports the following standards:

- WWW (World Wide Web) standards
- 3G (Third generation wireless format)
- CDPD (Cellular Digital Packet Data)
- GPRS (General Packet Radio Service)
- WAP (Wireless Application Protocol)
- SMTP (Simple Mail Transfer Protocol)
- SMS (Short Message Service)
- J2ME (Java2 Micro Edition)

Location Determination Technology (LDT)

LocationLogic works with both device-based and network-based LDT systems. An *LDT Adapter* architecture employed by LocationLogic allows for abstracting the underlying Location Determination Technology from the platform, and easy integration of a variety of Location Determination Technologies, which can be used to obtain location precision and level of confidence. LocationLogic provides several generic adapters to third-party LDT systems. However, if a proprietary application uses a non-supported LDT, a custom adapter can be created.

Note: An LDT simulator is provided with LocationLogic for testing and development.

Geocoding Engines

LocationLogic can support a number of geocoding engines. Custom location applications leverage an abstracted interface to communicate with any number of third-party geocoding packages and their proprietary data.

Connectivity to External Systems

The LocationLogic API can link to information external to the LocationLogic data store-- useful if applications require access to information in external systems. External systems, such as a CRM package, portal or any database, can be easily integrated with, and accessed by, applications via the LocationLogic API. For example, address book information utilized in an application hosted by LocationLogic may be accessed from an existing user database.

Global Content Integration

LocationLogic integrates with and stores large, multilingual data sets of POI features, street and road networks, and base map geometry data. Dynamic content, such as up-to-date traffic, news, weather and other subscription services, are also supported.

A LocationLogic application can easily scale with database expansion. For example, a geographic service area can double by simply adding to the road network database, and a LocationLogic application can access the additional information with no extra development effort.

Simplified Application Development

Applications access LocationLogic's services and integrated carrier network components through a rich Java API and an optimized, XML-based remote API. These APIs free the developer from the effort of integrating network infrastructure components, such as LDT, and managing low-level tasks, such as multiple database connections and transactions, and allows the developer to focus on creating applications that satisfy user requirements. The LocationLogic Java and XML APIs provide optimized environments along with the right tools for building location-based applications.

Java API

A set of Java classes and interfaces provide application-access to the functional components in LocationLogic (Enterprise Java Beans (EJBs) running within a J2EE application server). The Java API is ideal for applications requiring fine-grained access to platform functions that manage application-relevant information, such as users, user profile information, user locations, content, routes, and maps.

In addition, the Java API performs more complex platform operations, including manipulation of content and administrative functions, such as session and user management. A developer may use any of the commonly available Java development technologies to create applications with the LocationLogic Java API: Java Servlets, Java Server Pages, Java beans or Enterprise Java Beans.

The following list includes some of the functionality offered through the Java API:

- Device Location Determination
- Mobile User and Object Tracking
- Geocoding
- Route Calculation
- Mapping and Visualization
- Content Management and Navigation
- Spatial Searching
- User Administration
- Personal Data Management
- Application-Defined Logging

XML/SOAP API

LocationLogic offers an open and standards-based XML API that is an efficient, optimized and preferred means for remote application development. The XML API exposes the platform components (EJBs) as services based on SOAP (Simple Object Access Protocol) for interacting with the platform's most common service operations, such as geocoding, content searching and navigation, spatial query and generation of routes and maps.

Developers integrate applications using client-binding SOAP toolkits included with LocationLogic, which invoke XML-formatted requests sent over HTTP/HTTPS to LocationLogic's remote server interface. The XML/SOAP API is intended to compliment the Java API as an ideal remote development environment.

Rapid LBS Development Environment

The LocationLogic LBS Development Framework enables rapid application deployment and improves the performance, maintenance and extensibility of location-based services. Based on Apache Software's Struts initiative and the traditional Model-View-Controller software design pattern preferred for building Enterprise applications, it provides an open source framework that facilitates building applications using the J2EE Servlet and JSP technologies.

LocationLogic's framework combines best practices with application building blocks and can be used as the underlying architecture on which LBS applications are developed. Functionality it provides includes request dispatching, tag libraries to accelerate GUI development, internationalization and automatic form population. The framework promotes efficiency and rapid application development through the use of generic framework functions as well as by providing an environment to access reusable component-based services common to location-based applications, for example a service may provide abbreviated and localized travel itinerary narratives. The LocationLogic LBS Development Framework helps developers deploy location-based applications that are more reliable, scaleable, and easier to maintain.

Open Standards Based

Java 2

LocationLogic is a J2EE (Java 2 Enterprise Edition) application that takes advantage of Sun's Java 2 platform standards. Among a variety of other benefits, this architecture model ensures that LocationLogic components can be deployed anywhere, in any vendor's Java container system.

XML and SOAP

LocationLogic utilizes the open standards-based XML and SOAP technologies for supporting remote application development.

Database Connectivity

LocationLogic utilizes open database connectivity technologies, such as JDBC and SQL, to access content in an industry-standard spatial database management system: Oracle Spatial.

Standards Forums

Autodesk participates in a number of forums that help drive the design of this open architecture based platform.

Autodesk is an active participant in the WAP Forum, the Location Interoperability Forum (LIF), and is a Principal Member of the Open GIS Consortium (OGC). Autodesk's involvement history includes supporting and enabling the use of disparate data sets from multiple sources, including GPS and other location data.

Autodesk continues to work with LIF to develop standards for location-based servers, and is committed to producing standards-based products.

Autodesk also actively follows the standardization efforts of other organizations, including OGC's OpenLS test bed and the MAGIC Services Forum and Parlay, adopting technology standards as they mature.

LocationLogic Online Documentation

The following documentation is provided with LocationLogic:

- *Autodesk LocationLogic Developer's Guide*
- *Autodesk LocationLogic Java API Reference*
- *Autodesk LocationLogic Content Concepts*
- *Autodesk LocationLogic Installation and Configuration Guide*

To view or download any of these documents, visit: <http://locationservices.autodesk.com/docs>

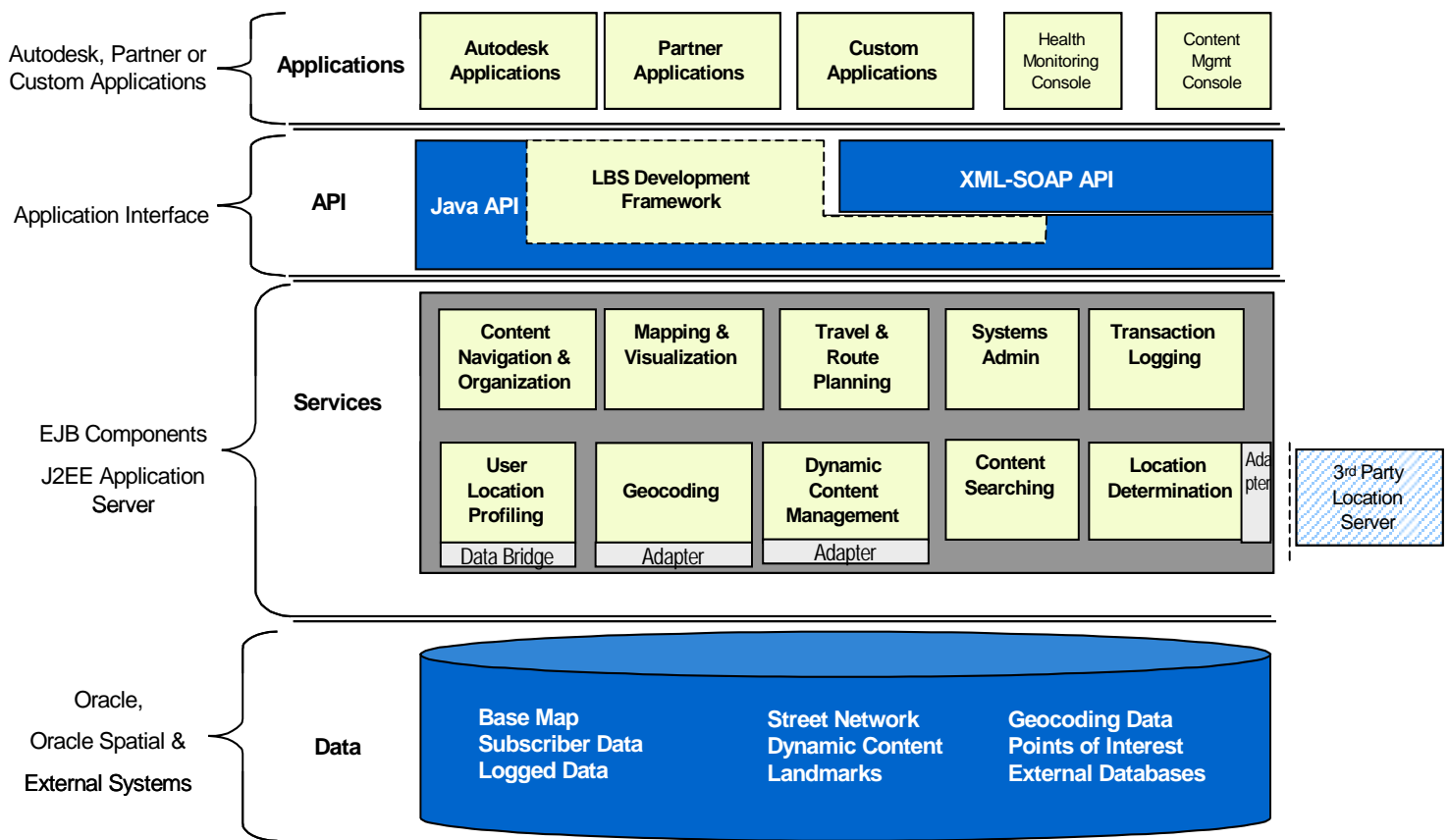
Please note that access to this site is restricted to authorized developers, and is password-protected. If you are interested in becoming a LocationLogic Developer and obtaining a login, or if you have forgotten your login, send email to: locationservices-developers@autodesk.com

Autodesk LocationLogic Architecture

LocationLogic-based solutions are comprised of a number of components internal and external to the platform technology. LocationLogic solution architectures, for example, may incorporate network infrastructure, external systems and content, custom components and location-based applications.

The platform itself is comprised of a content store, interface adapters for accessing external components, and a suite of services used to support location-based applications. The LocationLogic location-enabling services are exposed as Enterprise Java Bean components made available to an application developer through a Java and XML/SOAP API.

The following diagram shows the logical tiers and that make up a LocationLogic implementation, the component groupings and how they relate to each other. Conceptually, there are four main tiers represented—applications, interfaces, services, and the data tier.



Application Tier

Location-enabled applications typically exist in a web application server environment and utilize LocationLogic’s APIs to access or extend platform components and their functionality. The applications contain the logic and infrastructure for handling application-specific operations, such as session management, authentication, localization of content and formatting of device-specific content.

Interface Tier

In addition to a powerful Java API and an optimized XML-SOAP remote API, applications utilize a rapid location-based services development framework for building and deploying applications.

Services

LocationLogic's components are organized as subsystems and make the logic for client session management, device management, content transcoding and other functionality available to applications as services via LocationLogic APIs.

Note: This paper does not discuss the LocationLogic application framework, which supplies some of these functions.

Data Tier

The *data tier* contains the content that is available to LocationLogic functions, including the user profile and spatial databases.

The LocationLogic content database is the repository of all feature, road network, administrative area and base map data required by LocationLogic applications.

A standard set of tables is included for every application to maintain records about every feature in the database, as well as their relationships to each other. In addition to properties of specific features, the content database contains organizational information, such as how features are related to each other in a hierarchical fashion.

Using open, standard database connectivity methods, the content store supports geographic and location-specific data in both vector and relational database formats.

Location-Enabling Services

Location Determination Services

With LocationLogic, applications can locate mobile users by using location determination from an external LDT provider. More specifically, applications have access to a Mobile Object Manager component used to poll the network or a device for position, and to process varying resolutions of location information. LocationLogic's location determination functions support regions defined by unique cell properties, such as rings, disks and sectors.

LDT Adapters

LocationLogic utilizes an LDT Adapter architecture that seamlessly integrates with a carrier's network to obtain device location. An LDT Adapter is a module that "plugs-into" the LocationLogic infrastructure and abstracts the underlying LDT, providing a generic location and precision information interface for applications. Adapters built upon a proprietary LDT Adapter framework are available from Autodesk for many of the commercially available LDT products. Adapters can also be custom-built to interface with unique network technologies as required.

Location Refinement

Location refinement capabilities are built into LocationLogic's Location Determination Services. Location can be further refined through heuristics to calculate a list of probable locations within the location region returned by the LDT. These probable locations are generated by comparing the returned region against the following locations:

- The locations the user has book-marked
- The user's history (history is derived from the start and end points of previously calculated routes or manually assigned by the application)
- The nearest links on the underlying street network

With Location Determination Services applications can:

- Provide services based on a user location
- Invoke an LDT Adapter as needed to update users' location information
- Generate queries for a user's current location, with or without heuristic refinement
- Generate proximity queries for pairs of mobile objects
- Maintain a cached list of mobile objects to monitor
- Perform periodic updates of one or many cached mobile objects to monitor

User Management and Profile Services

Location-based applications often require a high degree of personalization. These applications need to perform tasks and deliver content based on unique personal information combined with a user's location.

LocationLogic provides a set of User Management Services that manages and maintains an application's unique user profiles and preferences.

User Administration

LocationLogic supplies interfaces to perform user administration. LocationLogic subscribers each have an associated account and are authenticated upon initiating an application session. Administrative functions, including the ability to view, create, modify, and delete individual user accounts and account information, are made available to LocationLogic applications. Only authorized "administrators" have access to these user administration interfaces.

User Profiles

Services are available to access and manage location-specific user profiles that include user permissions, properties and preferences. These services can specify whether a user is an administrator, or can be used to modify user-related data such as first-last name, phone number, email address, user id, etc. User profiles are used to store and manage routing preferences such as preferred travel mode and cost type (using shortest distance or time). Preferences also include the user's locale, which in turn controls their language preference.

With User Management Services applications can:

- Create, modify and delete user accounts and account information
- Grant, revoke and query permissions
- Set and retrieve user properties
- Set and retrieve the user locale and route preferences

Geocoding Services

Geocoding services allow applications to display tabular address data on a pushpin map, accurately show locations or events on a map, query to find geographic features by address and perform other operations.

LocationLogic offers geocoding services by integrating with third-party geocoding packages. Applications utilize a single interface to perform forward and reverse geocoding. Given an address or intersection, for example, LocationLogic returns possible matches and coordinate positions. Conversely, given a geographic location, LocationLogic converts it into an address or street intersection.

Geocoding Adapters

A Geocoding Adapter architecture provides the framework to abstract geo-spatial queries from the underlying geocoding engine. This component adapts third-party geocoding packages, so that custom applications utilize a consistent interface and do not have to manage the varied address formats used around the world.

With Geocoding Services applications can:

- Invoke a Geocoding Adapter, as needed, to perform a geocode operation
- Perform forward and reverse geocoding
- Return a match confidence level for each geocode

Content Management Services

The Content Management Services manage the location-enabled content database. The content database is the LocationLogic repository of all feature, road network, administrative areas and base map data required by LocationLogic software components. A standard set of system tables is defined in the database to specify the logical properties for different types of content data. In addition, one of the system tables contains organizational information, such as how features are related to each other in a hierarchical fashion. Each item in the hierarchy is commonly referred to as a feature category.

Location-enabled features stored in the content repository consist of many different types of data: locations, such as POIs, businesses, and facilities; mobile objects, such as other LocationLogic users; dynamic content, such as current traffic conditions; and user information, such as history, placemarks (bookmarked routes or locations), or personal information. Features are stored in a hierarchical feature category structure in the LocationLogic content database.

LocationLogic's Content Management Services retrieve information from the content database and perform all necessary spatial queries. These services are also responsible for administering the content database and allowing the organization of, and access to, almost any type of proprietary data. They also enable content and application administrators to create custom category navigation trees that streamline the end-user experience. Almost

any type of data can be supported through live, direct connections or indirect processing so that data can be overlaid and processed with other types of data.

Utilizing the LocationLogic Content Management Services, application developers provide users the ability to navigate and query a hierarchy of categorized content.

Content Navigation

The LocationLogic content store employs a feature category hierarchy scheme. The content hierarchy that defines the feature categories is established by the LocationLogic content administrator upon installation and set up. Content Management Services offer methods to efficiently access and navigate this application-defined model to find the feature a user is looking for. A feature category tree may look like the following:



User-Specific Content

Content Management Services manage a personal feature category hierarchy associated with each application user. Using the same methods to navigate and query application-specific feature data sets, developers can use a fixed feature category hierarchy to access user-specific information, such as location bookmarks, route bookmarks and location history. In order to perform specific tasks, such as book-marking a new location or route, adding a location to the user's history or adding another mobile user to a buddy list, developers can access specific methods that are designed for this purpose.

Data Bridge

The Content Management Services also provide methods for linking to content stored outside the LocationLogic data store. Once linked, applications perform content navigation and query operations on these external systems using the same methods used on LocationLogic's internal data store feature categories. These data bridge services become useful when applications require information from an external system such as a CRM database or portal's address book information. Some additional features of these services

are the ability to import external data into the LocationLogic data store, to geocode external data as needed, and the aggregation of information formats and sources.

Spatial and Relational Queries

Spatial and relational query functions are also found within the Content Management Services. Developers can utilize spatial proximity queries to refine location by identifying features around a location. The following types of spatial and relational queries are supported:

- Find all features that satisfy a custom SQL Where clause
- Find features closest to a specified location based on straight line (as-the-crow-flies) distances
- Find features closest to a specified location based on travel time or distance using a real street network
- Find closest features along a route. This could be performed on any previously generated route. For example, this search could be used to return all the gas stations along the route from a user's home to their office
- Find features closest to a specified location within a specified radius
- Find all features that contain a specified location
- Find features that are within a specified distance from a specified feature
- Find features within a specified region. This region could be comprised of the ring, ring sector, or disk sector returned from the LDT.
- Find closest features based on travel mode. For example, the closest ATM machine based on driving distance

All of the spatial queries above can also be combined with a SQL Where clause to further refine the query.

With Content Management Services you can:

- Navigate and query a hierarchy of categorized content
- Manage a user's personal location history
- Manage a user's personal location and route bookmarks
- Interface with external systems
- Refine a location by performing spatial proximity queries

Dynamic Content Management Services

Dynamic content, such as traffic, news or weather, can be easily integrated into applications using the Dynamic Content Management Services. These services consist of a framework to manage dynamic content feeds from third-party providers. This framework utilizes an adapter architecture to modularize custom interfaces to third-party content providers.

Referred to as *topics*, dynamic content, such as traffic information, experience events that are recognized by LocationLogic's applications. Supported by services that monitor event status, schedule content updates and parse data streams, Dynamic Content Management is invisible to applications. Developers utilize the same methods for retrieving and managing dynamic content as they do for static content in the LocationLogic database.

Dynamic Content Adapters

Dynamic content adapters transform third-party content into a topic-specific, canonical form suitable for LocationLogic applications. Incoming data streams are parsed into separate topic events, transforming third-party formats to conform with LocationLogic content store rules. Typically there are adapters for each unique combination of third-party provider and topic. For example, one adapter would provide the interface for processing dynamic traffic data from a single third-party vendor.

Dynamic Content Scheduler and Process Manager

The Dynamic Content Scheduler and Process Manager framework components trigger and perform updates of dynamic content. Each individual content topic is scheduled separately for monitoring and periodic updates. These operations run as background processes, and are managed by a systems administrator during deployment using simple configuration parameters.

With Dynamic Content Management Services applications can:

- Integrate dynamic content using simple Http requests to a third-party provider
- Invoke a custom adapter, as configured at deployment, for conversion services
- Seamlessly store the dynamic content in the LocationLogic database
- Configure periodic monitoring and updating of dynamic content

Route Planning Services

LocationLogic Route Planning Services calculate routes and turn-by-turn directions that meet specific requirements for travel from one place to another. For instance, an application can minimize travel time for a given transportation mode. Applications can create locations from addresses and features, such as attractions and businesses, and then add the locations to a route.

Optimal routes between two or more locations are generated using a memory-based cache of a street network model, which returns a list of *link Ids* (street segments) that satisfy the cost criteria and travel modes applied. This memory-based street network cache is loaded from the LocationLogic Oracle Spatial data management system, and is represented as a topological network of connected nodes and links. The following cost criteria and travel modes are supported:

Cost Criteria

- Shortest distance
- Shortest time
- Preferred roads

Travel Modes

- Driving
- Walking
- Bicycling

Route Planning Services also retrieve information such as orientation and street names for each link identifier returned, and calculate significant route travel steps for users to follow. Routes and their associated directions can be provided in textual format or as graphical maps.



Route Planning Services also support the following when generating routes and directions:

- Turn restrictions and estimated time required to make turns (left and right turns are evaluated independently and the time factor applied to a turn is configurable for both left and right turns)
- The side of the road drivers use for different regions
- Areas to avoid (either incident-related or user preference)
- Time-dependent routing (where a different route might be used during rush hour)
- Integration with additional real- and non-real-time data sources, such as traffic information and timetable information for rail and bus routes

With Route Planning Services applications can:

- Calculate routes between two or more locations
- Calculate routes or turn-by-turn directions that satisfy cost criteria and travel modes

Mapping Services

The LocationLogic Mapping Services visualize and render interactive maps that display spatial information, and navigation data such as routes and directions.

Maps used to highlight a route or a specific location can be easily generated using these services. Parameters applied to various Mapping Services and their methods allow for controlling map output format, map size, resolution and navigation controls, such as panning and zooming.

Map formats supported include bmp, wbmp, and png.

Administration and Monitoring Services

A framework of management components support LocationLogic's Administration and Monitoring Services. These components are responsible for managing discrete parts of the LocationLogic system, and make their services available to systems administration and monitoring consoles.

System Monitoring Console

A Health Monitoring Console determines the status of individual platform components and allows a systems administrator to monitor platform reliability and application up-time.

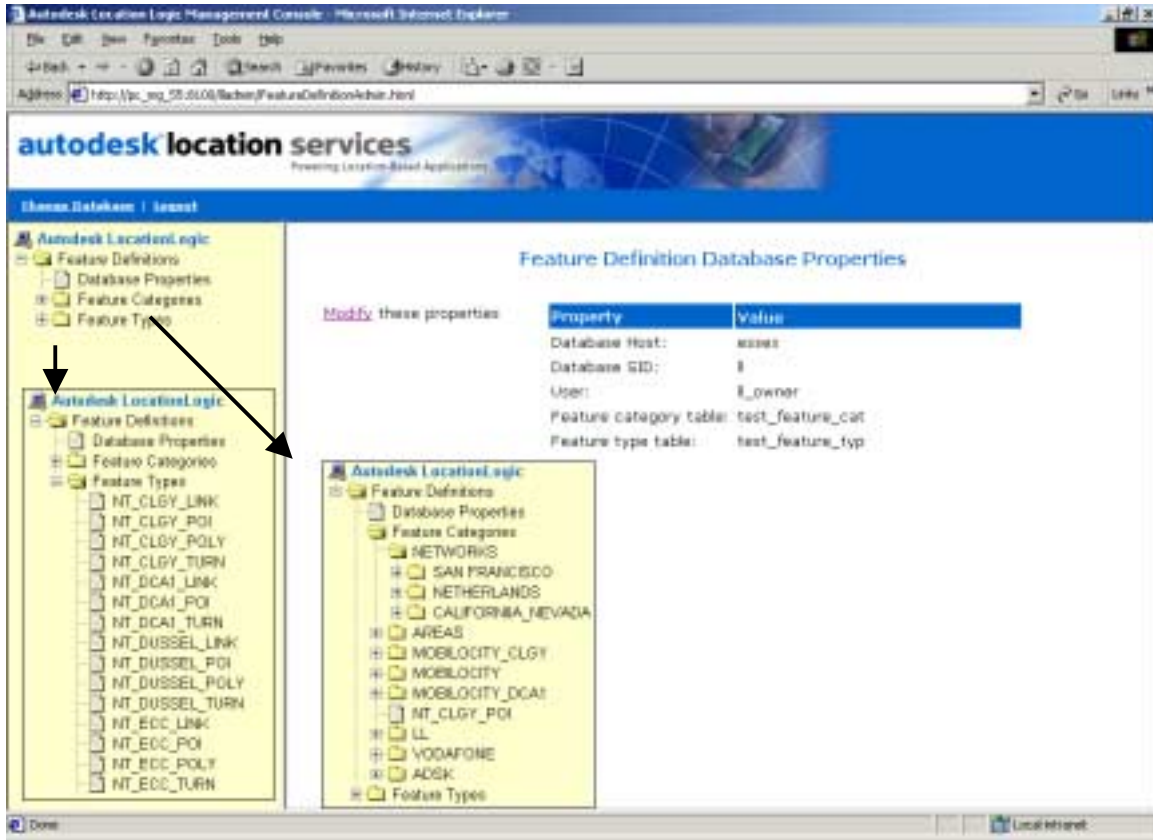
A collection of servlets and JSP pages, the Health Monitoring Console issues http requests to determine status of platform components. This server-side web application interacts with the Administration and Monitoring Services to securely present a web-based administration interface to a remote web browser via SSL. Both internal LocationLogic components (EJBs, etc.) and external components, such as database servers, are polled for their status and availability. The console's status information can be explicitly refreshed on screen, or configured to automatically refresh every couple of minutes.

Service	Status	Status Since
NetTrace	Running	Wed Sep 19 09:49:50 PDT
Account	Running	Wed Sep 19 09:49:50 PDT
Geocoder	Running	Wed Sep 19 09:49:50 PDT
NetTraceComp	Running	Wed Sep 19 09:49:50 PDT
RoutePlannig	Running	Wed Sep 19 09:49:50 PDT
NetCacheMgr	Running	Wed Sep 19 09:55:50 PDT
NtClusterManager	Running	Wed Sep 19 09:49:50 PDT
ContentManager	Running	Wed Sep 19 09:49:50 PDT
DbGateway	Stopped	Wed Sep 19 10:59:45 PDT
datasrc.jdbc/Oracle	Running	Wed Sep 19 09:49:50 PDT
datasrc.LLogicDataSource	Running	Wed Sep 19 09:49:50 PDT

Content Management Console

A Content Management Console allows a systems administrator or a content administrator to access tools that manage content via a simple, web-based interface.

Utilizing a content management framework and services within LocationLogic, the Content Management Console provides simple tools for modifying feature definitions within the LocationLogic data store. Functionality includes adding, deleting or modifying feature categories and feature types.

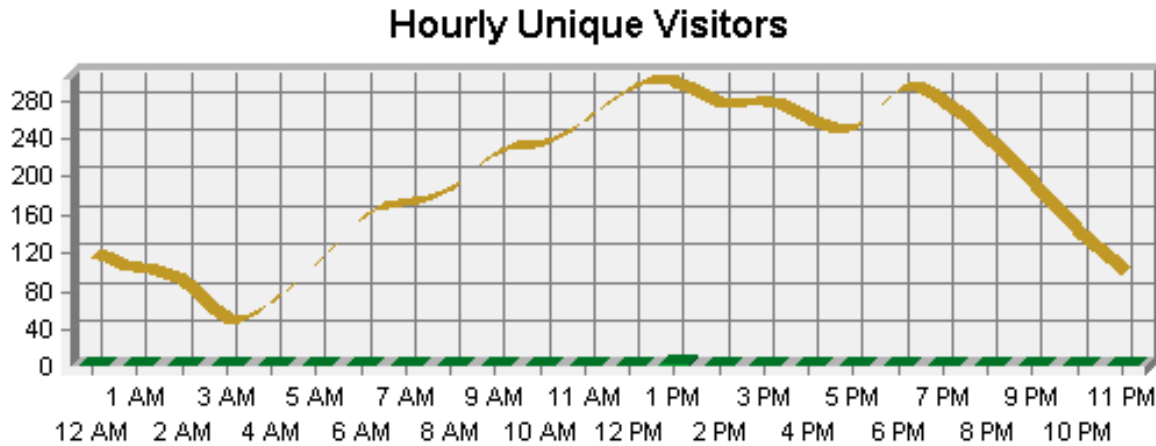


Logging and Reporting Services

Logging and Reporting Services record interactions with the various platform components, and make relevant information available to reporting and billing systems. Platform operations initiated by applications, such as performing geocodes, route and map generation and locating a device, are observed, described and stored in a relational database.

Logging is performed at different levels to effectively break operations into discrete, billable chunks. Services log operations that perform complete transactions (Full Cycle) such as "Find the nearest bank," as well as intermediate transactions (Steps), such as Authenticate / Authorize, "Get location from LDT," "Get base map from content provider" or "Get bank data from content provider." API methods allow even more flexibility and control by offering developers the ability to explicitly log any application-specific information associated with a session operation.

The logging capability of LocationLogic also supports context-sensitive, content-based billing models. This feature allows operators to track which content is used for what purposes, and also allows content providers to be compensated accordingly. All content access transactions log additional information that identifies the content accessed.



Reporting

Information that has been logged and stored can be used to generate user session statistics, usage and performance reports and a variety of custom reports. Data can be easily exported to external databases and third-party reporting or billing systems as required.

LocationLogic Applications

Building on the LocationLogic platform, applications can support a wide variety of applications:

- Providing geographic content, such as road network and base maps
- Providing location-based content, such as weather and traffic
- Routing, such as driving directions
- Select a feature (Point of Interest) based on distance (e.g. the three nearest banks)
- Dispatch an appropriately-located emergency crew
- Provide enhanced call routing
- Provide sight-seeing directions and information
- Support marketing campaigns (such as delivering location-relevant coupons)
- Tracking, including fleets (such as service vehicles)
- Billing, such as charging location-sensitive rates
- Offering value added analysis, such as traffic control or geo-marketing

Content Applications

A content application is one that provides location-relevant information to a group of users. The users may be subscribers to a particular wireless service, a group of employees, or a group that shares some other common information requirement. For a content-type LocationLogic application, the information can come from virtually anywhere, including the application developer, a third-party content vendor, or a customer's proprietary database.

By using *fine-grained* (precise coordinate) user location data, rather than zip code-based data, a LocationLogic application raises the effectiveness of general content by providing information that is truly location-relevant. By knowing precisely where the user is, applications and operators can promote nearby establishments, or provide timely messages such as local traffic warnings.

LocationLogic simplifies application development by removing a number of database access and navigation steps necessary to determine which content is location-relevant. In addition, users benefit from simplified content navigation on their mobile device interfaces.

Typical types of location-based content include:

- M-Commerce
- Yellow pages, white pages, directories
- News, weather, traffic
- Film and Review Cinema Guide
- Points of Interest (restaurants, landmarks, and so forth)
- Emergency alert (tornadoes, area avoidance, and so forth)

Personalized Applications

Most LocationLogic applications include at least some of the following *user personalization* (based on a personal profile) and user management components:

- Username and password management (by the user)
- User authentication, roles, and security privileges
- Demographic data provided by subscribers
- Book-marked locations
- Routing preferences
- Privacy controls on publishing and accessing a user's location

Some of these functions are exposed to the end user, while others are administered by the application or support organization. In all cases, a carrier's personalization engine can be extended with location-specific attributes.

Routing Applications

LocationLogic applications can provide a user with detailed routing information between two or more locations. The LocationLogic platform incorporates turn-by-turn directions, trip distance, and expected time into trips.

Through the LocationLogic personalization functions, users can specify routing preferences, including:

- Distance and speed units (for example, miles or kilometers)
- Transportation mode (for example, driving or walking)
- Cost criteria (for example, shortest distance, shortest time, or preferred roads)

Applications can leverage the routing functions to:

- Provide navigation from A to B
- Select a *feature* (Point of Interest) based on distance (i.e., the closest pharmacy)
- Dispatch an appropriately-located emergency crew
- Provide enhanced call routing
- Provide sight-seeing directions and information
- Support marketing campaigns (such as delivering location-relevant advertisements and coupons)

Tracking Applications

The LocationLogic location determination functions can track the position of almost any asset:

- People (community, children, elderly)
- Assets (vehicles, equipment)
- Fleets (service vehicles and personnel)
- Animals (pets, livestock, wildlife study subjects)

Billing Applications

Applications can use LocationLogic with an enterprise system to support location-sensitive billing applications, such as varied roaming charges.

Analysis Applications

In addition to the standard applications, a variety of value-added analyses can be deployed:

- Traffic *previson*—Predicting traffic problems based on current conditions
- Geo-marketing—Analyzing the identity, frequency and timing of subscribers who pass by a particular location
- Operator Network Quality of Service (QOS)—Designing systems for dynamic reconfiguration based on location of user demand
- Operator Network planning—Determining the location of cell tower installation based on previously collected location data

About Autodesk

Company Overview

Founded in 1982, Autodesk® is the world's leading provider of integrated design, GIS (Geographic Information Systems) and digital content solutions for enterprises. Autodesk provides design software, Internet portal services, wireless development platforms and point-of-location applications that help customers drive business and remain competitive through the power of continuous innovation. Serving a range of engineering and design disciplines, as well as high-end special effects, film, broadcast, and multimedia, Autodesk has more than 4 million customers worldwide.

Autodesk Location Services

As a leader in the mapping and GIS industry, Autodesk has developed proven technologies for building and disseminating geographic data and location-based solutions, which have been successfully adopted by government, communications, and enterprise customers for over a decade. In five years, Autodesk's GIS Solutions Division has grown into the third largest provider of GIS software in the world, with annual revenue exceeding US\$100 million.

Recognizing the demands of the exploding wireless market, Autodesk applied its business and technical experience to the requirements of location-based services (LBS) to form a new division—Autodesk Location Services—in 2000.

Autodesk Location Services directly employs over 150 people in San Rafael, California, Calgary, Canada and Milan, Italy. The division also leverages additional resources from the broader Autodesk infrastructure in IT, support, training and professional services.

Autodesk Location Services deliver the most advanced, scalable technologies and services for deploying LBS applications to users of wired and wireless devices. Location-based services attract new subscribers to system operators and increase average-revenue-per-user (ARPU), both critical metrics for profitability. Autodesk provides carriers with a solution that allows rapid deployment of location-enabled services, and Autodesk reduces the cost of deployment by aggregating applications that appeal to a broad subscriber base.

Building on Autodesk's core technology strength in mapping, visualization and location analysis, the company's development platform, Autodesk® LocationLogic, has been created from the ground up to meet the specific requirements of wireless communications. The platform's communications-centric architecture handles high volumes of transactions per unit of time, supports real-time data communication, and adapts to a wide assortment of popular end-user devices, including mobile phones, PDAs, and laptops.

The Autodesk Location Services solution makes it easy for developers to customize and add functionality to existing applications. Through an extensive array of application provider partners, Autodesk Location Services can also provide an end-to-end solution for location service needs, providing a market-ready suite of location-enabled applications that are immediately deployable.

autodesk®

Autodesk, Inc.
111 McInnis Parkway
San Rafael, CA 94903
USA

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