ArcPad®: Mobile GIS

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ArcPad: Mobile GIS

An ESRI White Paper

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ArcPad: Mobile GIS

Introduction

Mobile GIS is the combination of geographic information system (GIS) software, global positioning systems (GPS), and mobile computing devices. Mobile GIS fundamentally changes the way information is collected, used in the field, and shared with the rest of an organization. A mobile GIS allows you to visualize information in a digital map, collect information where you observe it, and interact directly with the world around you, while improving productivity and data accuracy.

Mobile GIS

Until recently, gathering and using information in the field was a paper-based process with multiple points of data entry without access to real-time information or the ability to accurately communicate field observations back to the office. The recent developments in mobile GIS technologies have benefited many field-based information gathering and use tasks by increasing the efficiency and accuracy with which field workers collect and use information.

Mobile GIS greatly improves the following field processes:

- Asset inventory—Recording the location and attribute information of an asset on a digital map

- Asset maintenance—Managing asset location, condition, and maintenance schedules in the field

- Inspections—Maintaining digital records of field assets for legal code compliance

- Incident reporting—Spatially recording accidents or events

ArcPad: Mobile Mapping and GIS

ESRI® ArcPad® software is used for mobile GIS and field mapping applications. ArcPad provides mapping, GIS, and GPS integration to field users via handheld and mobile devices. Data collection with ArcPad is fast and easy with field-based data validation and availability.

ArcPad increases the accuracy and efficiency of data collection and expands access to spatial data in the field. Collecting spatial information within a GIS while in the field improves the quality and accuracy of the data and minimizes administration and data entry time. In addition to more accurate data, ArcPad gives users direct access to spatial data in the field for on-the-spot decision making.

ArcPad provides mapping, GIS, and GPS integration to field users via handheld and mobile devices.

ArcPad integrates with ArcGIS® and other enterprise information technology. This integration lets ArcPad leverage existing investments in mapping, data, GIS software, and databases. ArcPad supports vector map and raster image display, which includes ESRI's shapefiles and LizardTech's MrSID® imaging language formats. Data collected in the field can easily be uploaded into the master database in the office. Data can also be transferred by the Internet via wireless communication. In addition, ArcPad offers integration with an optional GPS or differential global positioning system for real-time data capture.

ArcPad is compatible with numerous handheld, Windows CE, Pocket PC, Windows Mobile, and Tablet PC devices.

Many Potential Applications

ArcPad lends itself to a variety of industry uses. The ability to collect information in any location and store it in a spatial database enables improved processes and new efficiencies. ArcPad applications range from large deployments with hundreds of users to small applications of a single piece of software. Regardless of deployment size, all share a common benefit: improved efficiency and more accurate data collection.

ArcPad Use Across Industries

	Government	Utility and Infrastructure	Environmental	Public Safety
Asset Inventory	Street sign inventory Municipal assets (GASB 34) Tree survey	Recording installations Storm water inlet inventory	Toxic inventory Mineral exploration	Military fieldwork and mapping Aerial surveys Fire perimeter mapping
Asset Maintenance	Road condition surveys Street light survey	Power pole maintenance New equipment installations	Crop management	Locating buried infrastructure Patient registration
Inspections	Road pavement management Code enforcement Health inspections Housing conditions	Meter reading Septic system inspections Documentation	Habitat studies Weed abatement	Damage assessment
Incident Reporting	West Nile virus incidents Public nuisance surveys	Locating outages Regulatory compliance	Well sampling	Property damage assessment Accident reporting
GIS Analysis	GIS data validation Routing to locations	Locating customers for meter reading and billing Routing to locations	Calculating agricultural statistics	Locating customer addresses for investigations Identifying number of residents affected by an emergency

ArcPad is used in a variety of industries to improve data collection and accuracy.

Key Features

ArcPad is software designed to run on mobile computers. ArcPad has traditional GIS functionality such as map navigation, layering, querying, hyperlinks, and so forth. Experienced GIS users will be impressed with the comprehensive GIS capability that ArcPad offers on a portable device. New users will find the streamlined controls and menus easy to use and will be productive with little training.

The key features of ArcPad include support for industry-standard data formats; display and query functionality; editing and data capture; support for optional GPS receivers; and ArcPad tools for ArcGIS Desktop, which are used to prepare data for use in ArcPad.

Standard Data Formats

A key feature of ArcPad is the ability to use data directly from an individual's desktop or an organization's enterprise GIS system without the need to convert it to unique portable formats. ArcPad uses vector data in industry-standard shapefile format (as used by ArcInfo®, ArcEditor™, ArcView®, ArcIMS®, and other ESRI software programs). In addition, ArcPad directly supports the following raster image formats (world file required): JPEG, PNG, CADRG, MrSID (compressed images), and Windows® bit map (BMP).

ArcPad supports vector and raster data in a multilayered environment. Users can combine vector and raster data with the only limitations being the speed and memory capacity of the hardware in use. The map engine that supports the vector and raster data

was built and tuned in accordance with the Windows CE platform, and great care has been taken to maximize performance.
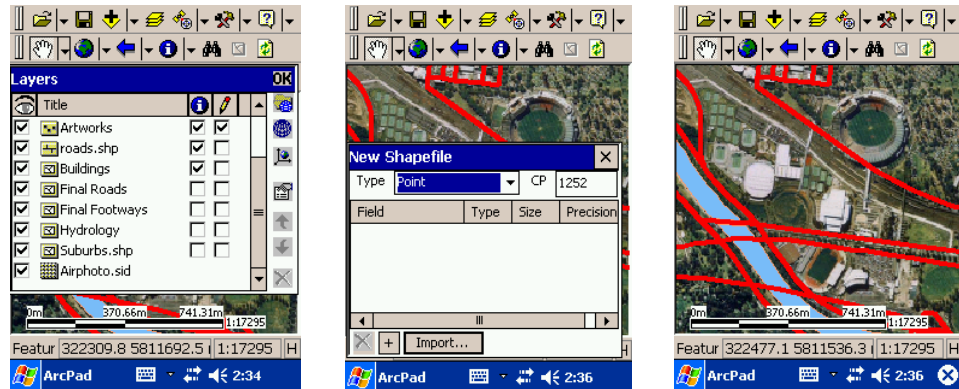
ArcPad allows users to create new shapefiles and view raster and vector data in a multilayer environment.

Spatial Index of Features

ArcPad supports the shapefile spatial index of features. A spatial index results in significantly improved draw and search times. Spatial indexes are created in ArcView 3.x or ArcGIS Desktop (ArcView, ArcEditor, or ArcInfo).

Projections

ArcPad supports the following projections:

- Geodetic or geographic coordinates (latitude–longitude)
- Albers Equal Area Conic
- Cylindrical Equal Area
- Double Stereographic
- Transverse Mercator (also called Gauss-Krüger)
- Lambert Conformal Conic
- New Zealand National Grid
- Stereographic

The above projections cover all Universal Transverse Mercator (UTM) projections (for example, Australian Map Grid [AMG], Map Grid of Australia [MGA], and many national grids). State Plane is covered by Transverse Mercator and Lambert Conformal Conic. The only State Plane zone not supported is Alaska Zone 1, which is an Oblique Mercator projection. ArcPad supports display of coordinates on the screen or incoming GPS coordinates in the Military Grid Reference System (MGRS).

Datums

ArcPad supports on-the-fly datum conversion from the geographic GPS input datum to the projection and datum of the current map. A database of 250 world datums is supported and can be expanded by users if required. This greatly simplifies the problem of datum matching between maps and the GPS hardware.

ArcPad supports any datum that meets the following criteria:

- The transformation parameters for going to WGS84 are known.

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■ The transformation uses one of the following equation-based methods: Bursa-Wolf (which is treated the same as Coordinate Frame), Coordinate Frame, Geocentric Translation, or Position Vector.

■ Datums that require grid-based transformations to go to WGS84 are not supported.

Display and Query   ArcPad includes a comprehensive set of map navigation, query, and display tools. These tools are designed to accommodate working with spatial data on mobile devices in field locations.

Map Navigation   ArcPad has a number of map navigation tools including variable zoom and pan, fixed zoom, zoom to a specified layer or spatial bookmark, and center on the current GPS position. Users can also zoom to the extent of all visible layers or pan to features selected by an attribute search.

Query   ArcPad enables users to identify features and display their associated attributes; display layers with scale dependencies; create a hyperlink to external files including photographs, documents, video, or sound recordings; measure distance, radius, and area on-screen with the touch of the map; and calculate geographic statistics for selected features such as area and length.

Display   Users can control on-screen presentation of map data on a layer-by-layer basis in ArcPad. Users can set layer display properties such as color, style, thickness, and fill patterns; text labels; and graduated symbols as required. ArcPad supports simple labeling for points, lines, and polygons and angled label text. Symbols must be defined using ArcView 3.x or ArcGIS Desktop. Users can also choose to display an optional scale bar.
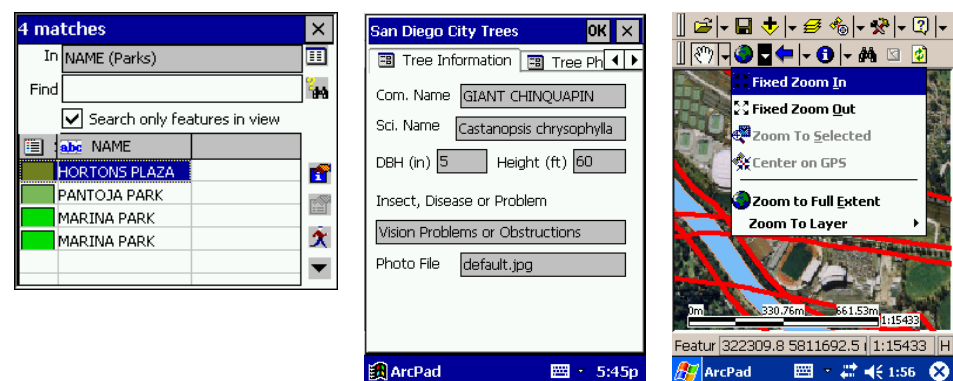
ArcPad allows users to query data, locate features, and navigate maps in the field.

Editing and Data Capture   ArcPad supports data editing, creation, and updating in the field through edit tools and data entry forms for recording attribute information. ArcPad allows users to create, delete, and move point, line, and polygon features in shapefiles. In addition, users can add, delete, and move vertices for lines and polygons and append vertices to existing features. The coordinates for these features are also editable with the option to use current GPS coordinates to replace less precise measurements. Shapefiles can be created

in ArcPad using input from pen, cursor, or GPS. ArcPad also supports capturing GPS points while in the process of capturing a line or polygon with the GPS (nested points).

In addition to location information, attribute information can also be stored with a location in a shapefile. After adding a new location (tapping the screen or input from a GPS), a form opens automatically allowing you to fill in attribute information about that location. Attributes can be entered and manipulated through the built-in editing interface or through a custom form created using ArcPad Application Builder. Forms can consist of multiple pages and can include required fields, read-only fields, and horizontal and vertical scroll bars for multiline edit fields.

Form Creation Wizard

A free applet is available on ArcScripts that lets users create data collection forms on the fly from shapefiles in ArcPad. This applet includes a wizard to walk the user through the form creation process. Search ArcScripts for keyword "form creation."
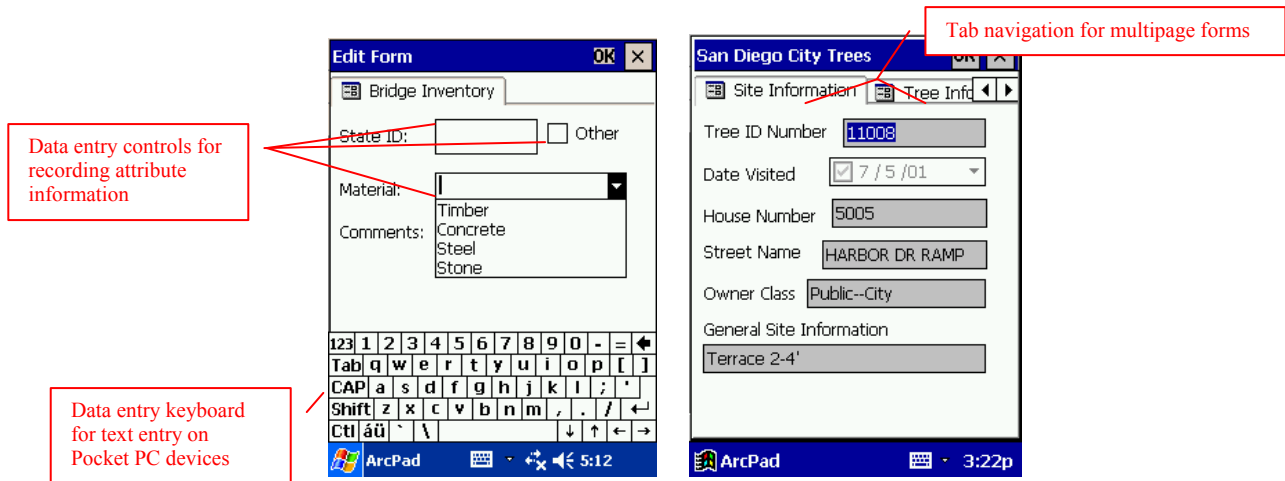
ArcPad forms support multiple pages and data validation for ease of use and accurate data.

GPS Support

ArcPad offers integration with an optional GPS or differential global positioning system (DGPS). With an optional GPS attached, ArcPad displays an individual's current position on the map in real time. Position coordinates are instantly available at the touch of the stylus on the map.

Supported GPS Receivers

GPS support for basic navigation and GPS data capture is available worldwide to all receivers that support any of the following GPS protocols:

- NMEA 0183 (National Marine Electronics Association)
- TSIP (Trimble Standard Interface Protocol)
- DeLorme Earthmate binary protocol
- Rockwell PLGR GPS binary protocol

ArcPad can display the following GPS information: receiver model and version, GPS mode (two-dimensional, three-dimensional, DGPS), Speed Over Ground (SOG), Course

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Over Ground (COG), constellation, signal quality, position, altitude, compass, and differential (on/off). ArcPad includes a debug window for displaying messages received from the GPS and a message option to send messages to the GPS.

Find GPS A free extension is available on ArcScripts to make working with a GPS in ArcPad more streamlined. The Find GPS extension was created to automatically search for a GPS receiver and update the GPS settings in ArcPad. This extension is also useful for diagnosing GPS hardware problems using ArcPad. Search ArcScripts for keyword "autodetect."

GPS Data Capture Using ArcPad, data collection with a GPS is significantly improved over using traditional GPS device-centric or proprietary methods. With ArcPad, GPS coordinates are automatically stored in a GIS file format (shapefile) and can be opened directly by other GIS software. All GPS data can be recorded as a "track log" that is stored as a point shapefile, stored as a point location (waypoint), or used to capture polygons and polylines in a shapefile. With ArcPad, users are also able to collect attribute information associated with the GPS coordinates and store it in the same shapefile.

ArcPad supports the following data capture options with a GPS receiver:

- Support for point mode digitizing (i.e., the ability to capture explicit points as opposed to stream mode digitizing)

- Support for position averaging when capturing a point feature and a vertex for a polyline or polygon feature

- Ability to pause the capturing of GPS line or polygon features and resume capturing at a later stage

- Option to set the maximum thresholds for error messages such as position dilution of precision (PDOP) and estimated position error (EPE)

- Option to activate an alarm when the GPS mode changes (two-dimensional, three-dimensional, and differential GPS) and automatically stop GPS data capture

- Ability to specify minimum time intervals between GPS positions used for data capture of vertices
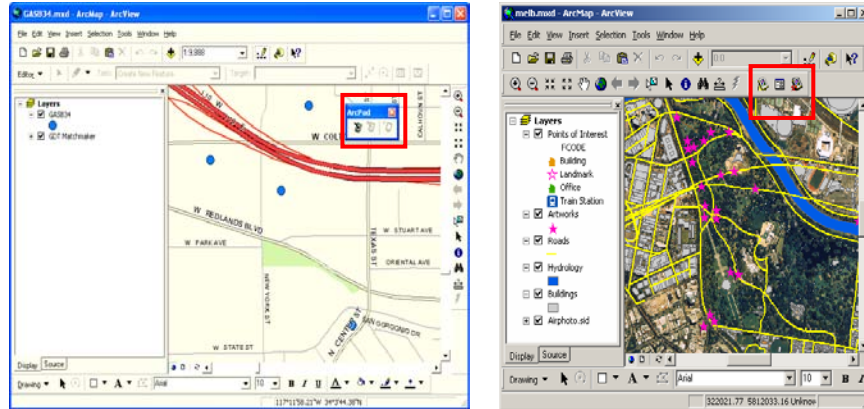
ArcPad Tools for ArcGIS Desktop The ArcPad tools for ArcGIS Desktop allow you to extract, convert, and project your data using ArcGIS 8.1 Desktop or higher products (ArcView, ArcEditor, or ArcInfo).

Use ArcPad tools for ArcGIS Desktop for

- Preparing data for use in ArcPad

- Exporting ArcGIS Desktop layer symbology into ArcPad layer (APL) files

■ Creating ArcPad map (APM) files

■ Packing shapefiles

■ Converting data from a geodatabase or personal geodatabase into a shapefile for use in ArcPad with symbology

Take data maintained in ArcGIS into the field with ArcPad tools for ArcGIS.

Some of the ArcPad tools are available for ArcView 3.x for transferring data and projects to ArcPad.

Internationalization and Localization

The ArcPad user interface is available in a number of languages, making use easier for mobile GIS workers whose native language is not English. Localized versions of ArcPad are currently available for the following languages:

■ Bulgarian
■ Chinese (Hong Kong)
■ Chinese (Simplified)
■ Chinese (Traditional)
■ Czech
■ Danish
■ Dutch
■ French
■ German
■ Hungarian
■ Italian
■ Japanese
■ Korean
■ Norwegian
■ Polish
■ Romanian
■ Spanish
■ Swedish (new at ArcPad 6.0.3)
■ Thai
■ Ukrainian

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System Requirements
ArcPad has been designed to offer advanced GIS capability on mobile devices. ArcPad will also run on traditional desktop, laptop, and tablet computers offering a variety of deployment options.

ArcPad supports the following operating systems:

- Windows Mobile 2003 Second Edition for Pocket PC

- Pocket PC, Pocket PC 2002, and Pocket PC 2003 (also known as Windows Mobile 2003 for Pocket PC)

- Windows CE .NET (CE 4.1 and 4.2)

- Windows CE 2.11, 2.12, and 3.0

- Windows 95/98/2000, Me, Windows NT®, and Windows XP (including Tablet PC)

ArcPad is designed for the following CPU chips:

- ARM (including StrongARM and XScale)
- Hitachi SH3 and SH4
- MIPS
- x86

These chips account for the majority of Windows CE devices currently available including the Pocket PC, palm-size, handheld, notebook, and pen computer varieties.

ArcPad has a low minimal hardware requirement and will operate on a 32 MB memory (64 MB recommended), 133 MHz processor, with approximately 10 MB of free disk space. A typical Windows CE system would have 64 MB memory, 266 MHz processor, a color display, and a memory card for extra map data. ArcPad imposes very few hardware requirements; equipment specifications are typically based on the user's needs and the type and volume of map data to be used.

Customization Framework: ArcPad Application Builder
ESRI's ArcPad Application Builder is a development framework for building custom mobile GIS applications with ArcPad. Tailoring mobile GIS applications to a work force's functionality needs, skill level, and work flow ensures the highest levels of efficiency and efficacy from the deployment. ArcPad Application Builder allows you to integrate technology such as digital cameras, monitoring devices, and other hardware and software into data collection with ArcPad. ArcPad Application Builder is a separate product for creating custom applications deployed to devices running ArcPad.

ArcPad Application Builder: Key Features
ArcPad Application Builder is an essential component of a successful mobile GIS deployment. It allows applications to be created that match functionality and usability with the skill level and processes of field-workers. With ArcPad Application Builder, mobile GIS applications ensure accurate data collection and streamlined work flow.

All customization for ArcPad is performed on the desktop using the ArcPad Studio application and deployed with ArcPad on the mobile device. ArcPad Application Builder provides the tools to customize ArcPad but is not required to utilize a customized version of ArcPad.

ArcPad Application Builder enables users to

■ Design custom forms to streamline data collection in the field.
■ Create new toolbars that contain built-in and custom tools.
■ Build applets and scripts, enabling ArcPad to solve specific field-based problems.
■ Develop applications that interact with ArcPad software's internal objects.
■ Develop extensions to support new file formats and positioning services.
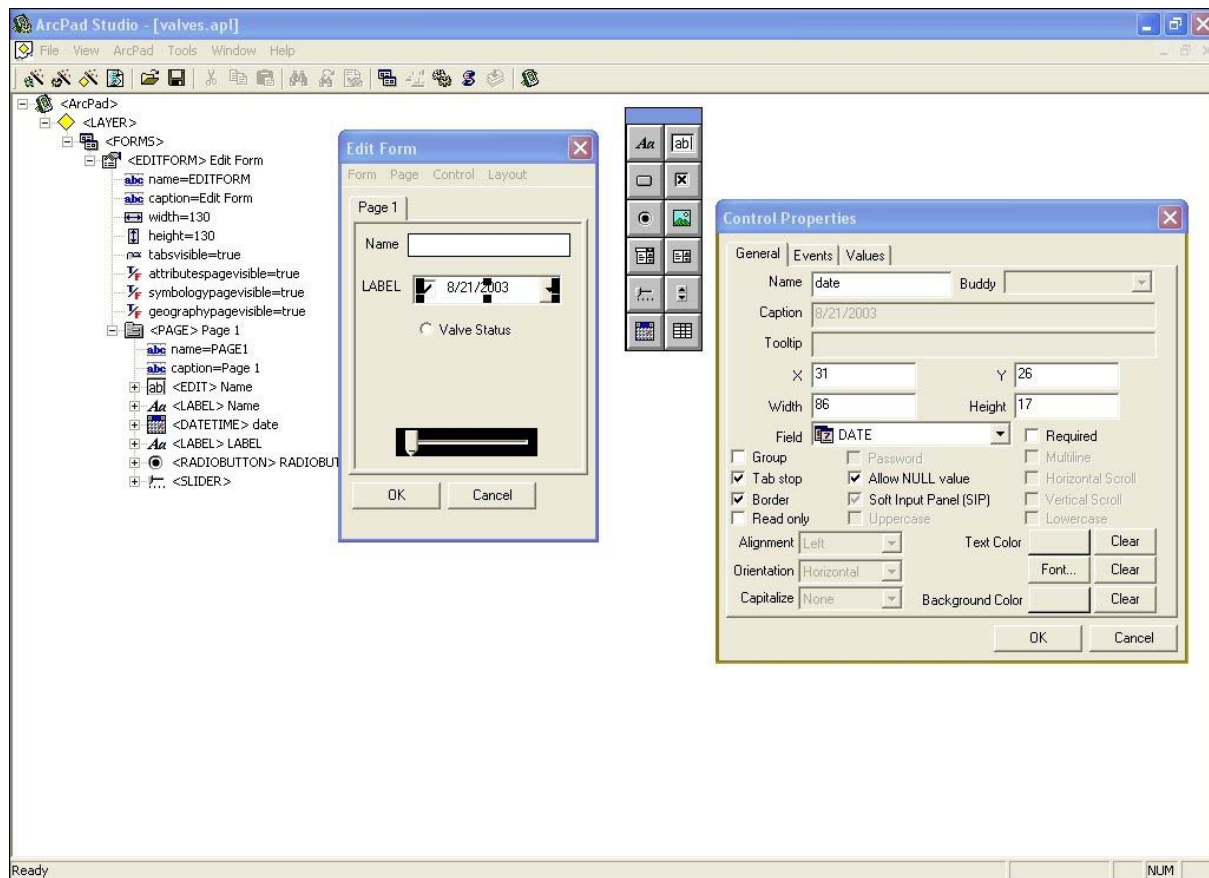
Extension: ArcPad StreetMap   ArcPad StreetMap™ is an ESRI extension to ArcPad providing street-level data, routing, and geocoding capabilities to ArcPad projects. ArcPad StreetMap gives users greater location awareness in their field applications by providing an interactive layer of street data and tools that integrates with existing spatial data, aerial photographs, and data entry forms.

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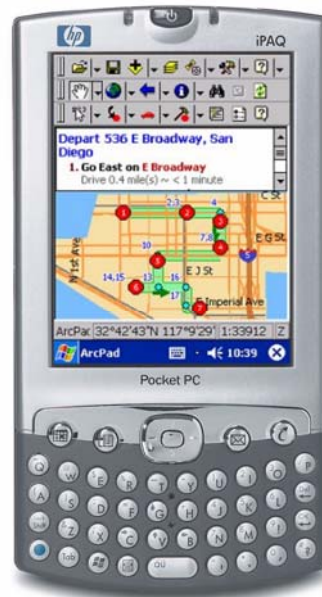
*ArcPad StreetMap extends mobile
GIS applications with street data,
routing, and geocoding.*

ArcPad StreetMap overcomes the limitations of carrying detailed street data into the field
on a mobile device through its desktop data extraction and compression tools. ArcPad
StreetMap allows for greater coordination between mobile GIS and other ESRI routing
and logistics software through the shared use of .grf files.

Key Features   ArcPad StreetMap was designed to increase the efficiency of field users by integrating
street and location data into existing ArcPad applications. With optimized routing, users
can specify stops and find the quickest route between them. Users can locate their
address with a tap on the map or enter address information to find their location.

■   Integrate high-quality U.S. street-level data with your existing ArcPad map
documents.

■   Use detailed street and landmark data with predefined symbology.

■   Perform advanced address matching.

■   Identify an address with a tap on the map.

■   Generate a route and optimize your stops.

■   Navigate your route easily with driving directions.

■   Create stops, barriers, and pushpins on your route.

Many Potential Applications

ArcPad StreetMap is a mobile GIS and routing solution that was designed for mobile workforces in utility, environmental, public safety, transportation, code enforcement, and other industries. Enabling a workforce with the ArcPad StreetMap street data and routing capability will benefit an organization in many ways.

- Improve productivity by scheduling more stops per trip.
- Achieve greater efficiency by reducing miles traveled.
- Improve customer service through quicker response times.
- Minimize overhead through worker flexibility.

ArcPad Templates

ArcPad lends itself to a variety of industry applications. The ability to collect information in any location and store it in a spatial database enables improved processes and new efficiencies regardless of industry. ESRI has many resources, including sample industry templates (http://www.esri.com/publicarcpad), that can guide you on the road to creating ArcPad applications. These templates highlight specific applications of ArcPad technology to solve industry problems. These templates vary from tools to applets to forms, all of which illustrate the practical benefits of ArcPad. These templates are not designed as end solutions; rather, they are a starting point for creating your own ArcPad project.

A variety of ArcPad templates is available for the following industries and more:

- Health and human services
- Infrastructure and utilities
- Natural resources
- Public safety
- State and local government
- Urban and regional planning

ArcPad Strategic Partners

Several ESRI business partners specialize in ArcPad applications. These partners have significant experience and expertise applying mobile GIS and ArcPad to solve problems.

The ArcPad Strategic Partners page on the ArcPad product Web pages offers a directory of applications and solutions for mobile GIS users.

Find technical solutions for

- Data management and integration
- GPS differential correction in the field
- Voice control of ArcPad

Learn about specialized ArcPad applications for

- Water monitoring
- Mosquito control
- Golf course management
- And more

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More Information For more information on ArcPad, ArcPad Application Builder, ArcPad StreetMap, ArcPad templates, or ArcPad strategic partners, visit www.esri.com/arcpad.

To download an evaluation copy of ArcPad, visit www.esri.com/downloadarcpad.