Esri International User Conference | San Diego, CA

Technical Workshops | July 14 2011

Working with Temporal Data in ArcGIS

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This Workshop

- Time in ArcGIS
  - Temporal mapping
  - Sharing Temporal Data
- Managing Temporal Information
- Temporal Data Visualization in ArcGIS

Time in ArcGIS

Time and GIS

- **Concepts:**
  - **Different ways to measure and model time**
  - **Common patterns used with temporal GIS**
- **ArcGIS 10**

Calendar Measurement – Gregorian Calendar

- **Is not metric or base 10 – difficult to compute**
  - **A Year is 365, or sometimes 366 days (leap year)**
  - **A Month can be 31, 30, or 28 days, *or 29!***
  - **Weeks and Months are not aligned**
  - **A Day is 24 hrs**
    - **but hours are 60 minutes**
    - **minutes are 60 seconds**

Non-Calendar Measurement – Indexed Time

- Represented as a numeric attribute
- Can be arbitrarily assigned
- Features are sequenced by numeric order
- Events occur on a “number line”
- Use with Interval setting
  - Cannot vary time difference between indexes

Non-Calendar Based Measurement - Epochs

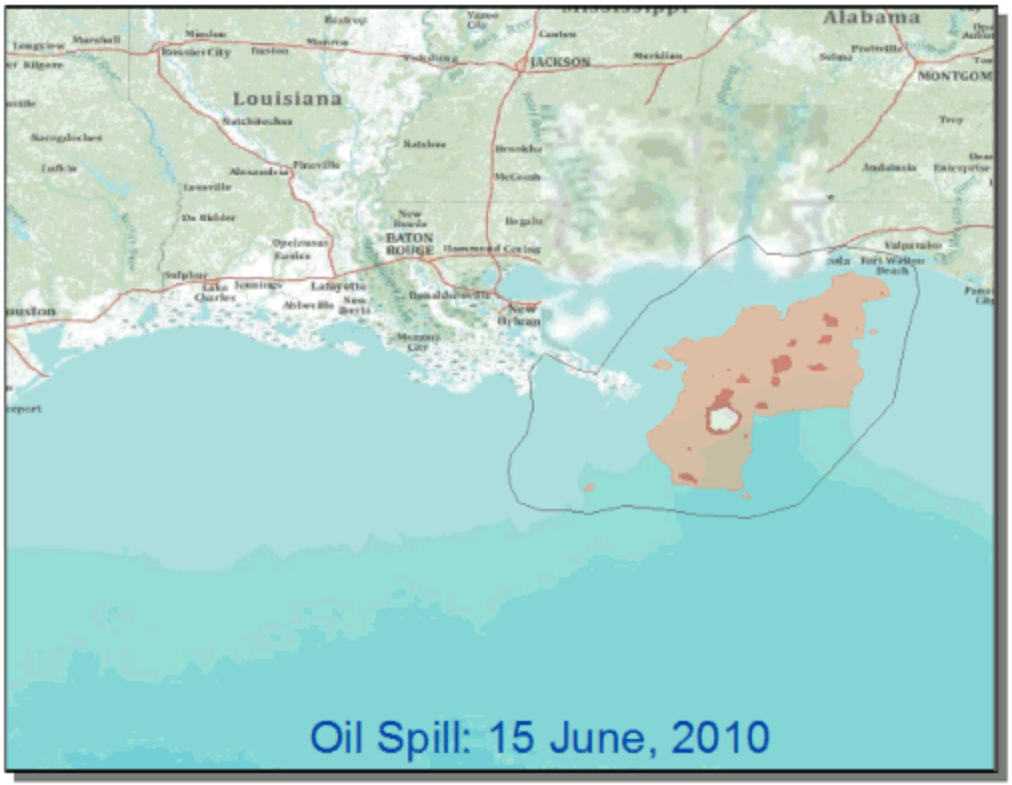
1310675995... 1310675996... 1310675997... 1310675998... 1310675999... 1310676000...

- **Index of units elapsed since an epoch (epic?) event**
  - **Unix / Java / Oracle – "Count of seconds since 1/1/1970"**
    right *NOW* would be: 1310676000 (July 14 2011 20:40:00 GMT)
  - **Windows / .Net "DateTime" – Count of 100 nanosecond units (ticks)**
    - **12:00:00 A.M *January 1, 0001* through 11:59:59 P.M *December 31, 9999* A.D.**
    - **Example: 12:00:00 midnight, Jan 01, 0100 = 31241376000000000 ticks.**
  - **Epoch units are internal to a system – convert to Calendar units!**
    - ***Store your temporal data as DATE type – not an epoch unit***
    - ***Always use the Operating System or Platform API's for conversion***

Additional properties of Time

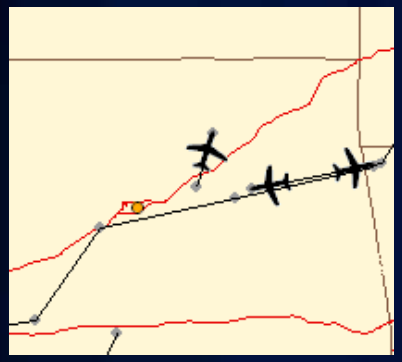
- Time is Linear
  - Wednesday always follows Tuesday
- Uni-directional
  - Events which happen today don’t affect yesterday
- Time can be Cyclical
  - June 20th happens every year

Why visualize data through time?



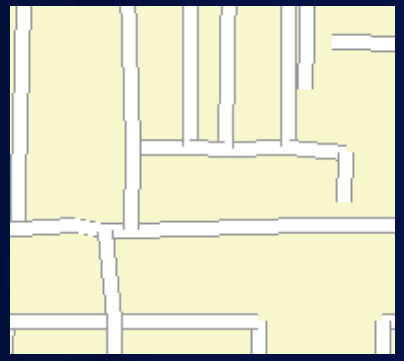
Temporal GIS Patterns

Dynamic
something that moves



- Planes
- Vehicles
- Animals
- Satellites
- Storms

Discrete
something that "just happens"

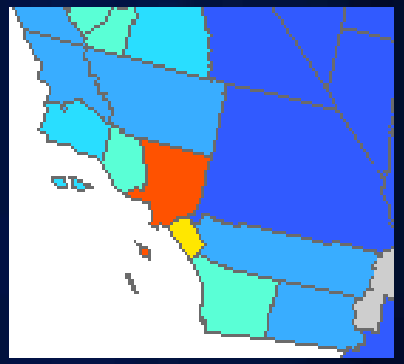


- Crimes
- Lightning
- Accidents

Stationary
stands still but records changes

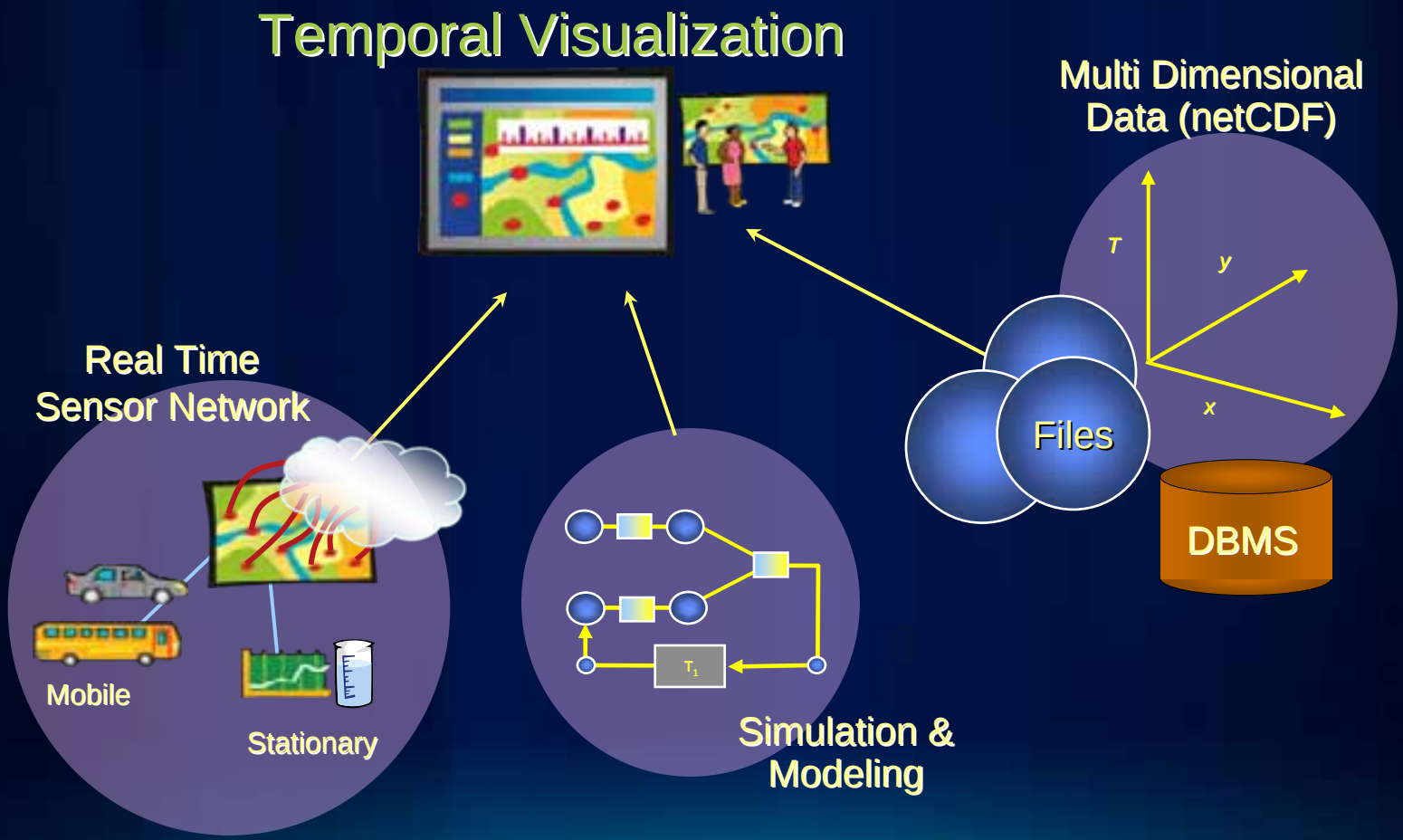
- Weather Stations
- Traffic Sensors

Change
change or growth



- Population
- Distribution
- Fire Perimeter

GIS Integration of Time



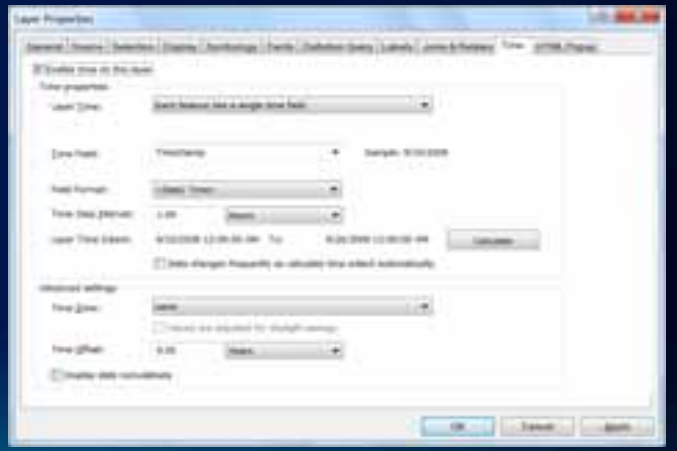
New Ways to Manage, Visualize & Analyze Geography

Time is Built-In to ArcGIS

- **Simple Temporal Mapping**

- **Unified experience for Time**
  - Configure time properties on the layer
  - Use Time Slider to visualize temporal data

- **Share temporal visualization**
  - Time-enabled Map Services
  - Export videos or images
  - Generate temporal map books using ArcPy scripting
  - Layer and map packages



Temporal Mapping in ArcGIS 10

- The map is now time aware
- Create, interact, and serve temporal maps
- Unified experience for Time
  - Works the same in ArcMap, ArcGlobe and ArcScene
  - Part of Desktop, Engine and Server products

Sharing Temporal Maps & Data with ArcGIS 10

- Publish time-aware maps
- Export videos or images, layer and map packages
- Visualize data
  - Access via REST API
  - Web API
    - FLEX
    - JavaScript
    - Silverlight
  - Time Slider web control
  - ArcGIS Online

Time in ArcGIS Demonstration

Managing Temporal Information in ArcGIS

Ways to model temporal data for use in ArcGIS

- **Time Instant**
  - “Point” in time of a specific feature
  - A sample from continuous data
  - “Observation”, “Event”, etc…
- **Time Extent**
  - A time span, an interval or duration
  - Describes characteristics over a period (start date – end date)
- **Time As Attribute Value**
  - Additional attribute when more than one are used
  - Legal representation such as “valid time”
- **Transactional Time**
  - System generated, auditing (in the database)
  - Provides revision or history management
  - Time Window can be created in SQL view or Query Layer definition

Store Temporal Data – *DATE* field type

- DATE is a special field type specific to time
- GeoDatabase provides DATE – maps to RDBMS SQL ‘DATE’
  - Not all databases support the same type and operators
- If at all possible – use DATE type
  - It’s better, faster, easier
  - Only use String or Number if importing old data
  - Learn to convert
- DATE field should be indexed for faster query performance

Other supported formats - Numeric and String

- **Numeric**
  - **YYYY**
  - **YYYYMM**
  - **YYYYMMDD**
  - **YYYYMMDDhhmmss**

- **String**
  - YYYY
  - YYYYMM
  - YYYYMMDD YYYY/MM/DD YYYY-MM-DD
  - YYYYMMDDhhmmss YYYY/MM/DD hh:mm:ss YYYY-MM-DD hh:mm:ss

- **Only ‘sortable’ formats are supported**
  - **Numeric: (YYYYMMDD) 20090630 > 20080830 = TRUE**
    (MMDDYYYY) 06302009 > 08302008 = FALSE
  - ***Named Month* strings sorted alphabetically!**
    - **April, August, December, February, etc…**
    - **Which is first, “DEC-10-2009” or “FEB-10-2009” ?**

What if your time is not one of those formats?

- Use the Convert Time Field GP tool
  - Converts numeric & string formats to a date field
    - "20100321" → 03/21/2010
  - Converts custom string formats to a date field
    - "March 21, 2010" → 03/21/2010

Input time field with time values stored in the custom format MMMM d, yyyy HH:mm:ss

Input_Table

OBJECTID *	Shape *	Input_Time	Output_Time
1	Polygon	January 21, 1988 17:12:57	1/21/1988 5:12:57 PM
2	Polygon	August 28, 1998 00.01.01	8/28/1998 12:01:01 AM
3	Polygon	August 10, 2001 19.56.30	8/10/2001 7:56:30 PM
4	Polygon	September 7, 2002 5.00.00	9/7/2002 5:00:00 AM
5	Polygon	July 31, 2003 13:45.00	7/31/2003 1:45:00 PM
6	Polygon	August 23, 2009 17.30.00	8/23/2009 5:30:00 PM
7	Polygon	July 18, 2010 11:00:00	7/18/2010 11:00:00 AM

Supported data

- Feature Layers
- Data tables
- Mosaic Datasets & Raster Catalogs
- NetCDF (Raster, Feature, Table)
- Tracking Layers
- Network Layers
- … much more

Supported data - Feature Layers

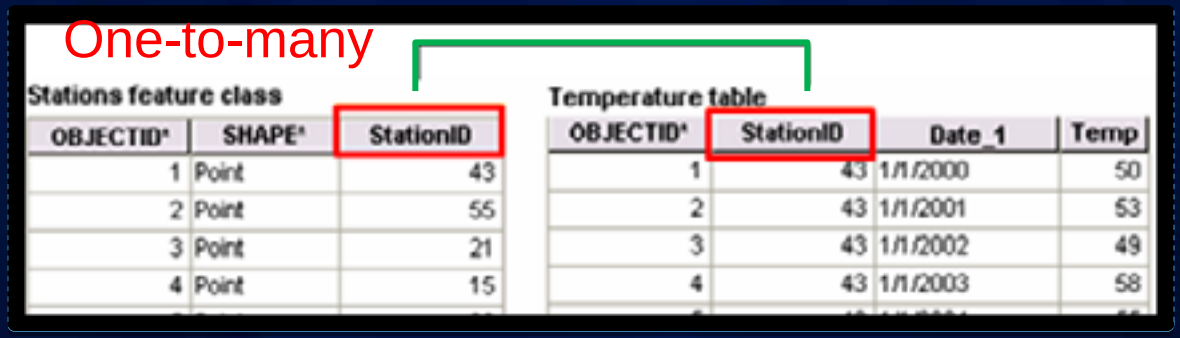
- With one table, features repeat for each time stamp
- Each time stamp has an attribute value
- This model is commonly used for capture or playback of moving objects. (Tracking)

Attributes of Monitoring Points

FID	Shape *	FeatureID	TSValue	TSDateTime
0	Point	9679	33	12/1/1999
1	Point	9679	29	12/2/1999
2	Point	9679	26	12/3/1999
3	Point	9680	66	12/1/1999
4	Point	9680	58	12/2/1999
5	Point	9680	54	12/3/1999

Supported data - Feature Layers (continued)

- With two tables, if your table relationship is:
  - One to one
  - One to many
- Create a join between the layer and the time-series table
  - Add Join GP tool
  - Join on the Layer Properties (Join & Relates tab)
  - Optionally, use the Make Query Table GP tool to create an in-memory layer



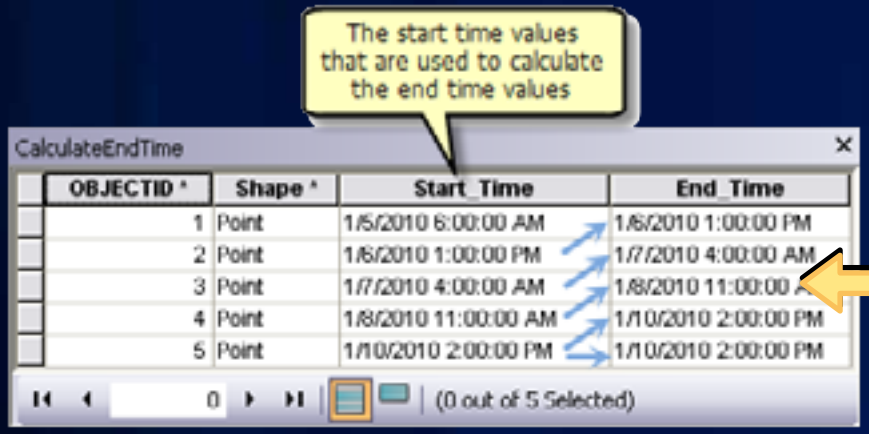
OBJECTID*	SHAPE*	StationID
1	Point	43
2	Point	55
3	Point	21
4	Point	15

OBJECTID*	StationID	Date_1	Temp
1	43	1/1/2000	50
2	43	1/1/2001	53
3	43	1/1/2002	49
4	43	1/1/2003	58

- This model is commonly used with fixed position samples, such as weather stations and other sensor networks

Representing Time Span with Two Fields

- **Sometimes there is a need to imply that a duration existed between each instant in time feature**
- **Populate the End time field with the next successive records Start time.**



The **Calculate End Time** tool can create this end date field for you.

- The last **instance will not have a duration as the End time and Start time will be the same.**

Supported data - Mosaic Datasets Raster Catalogs

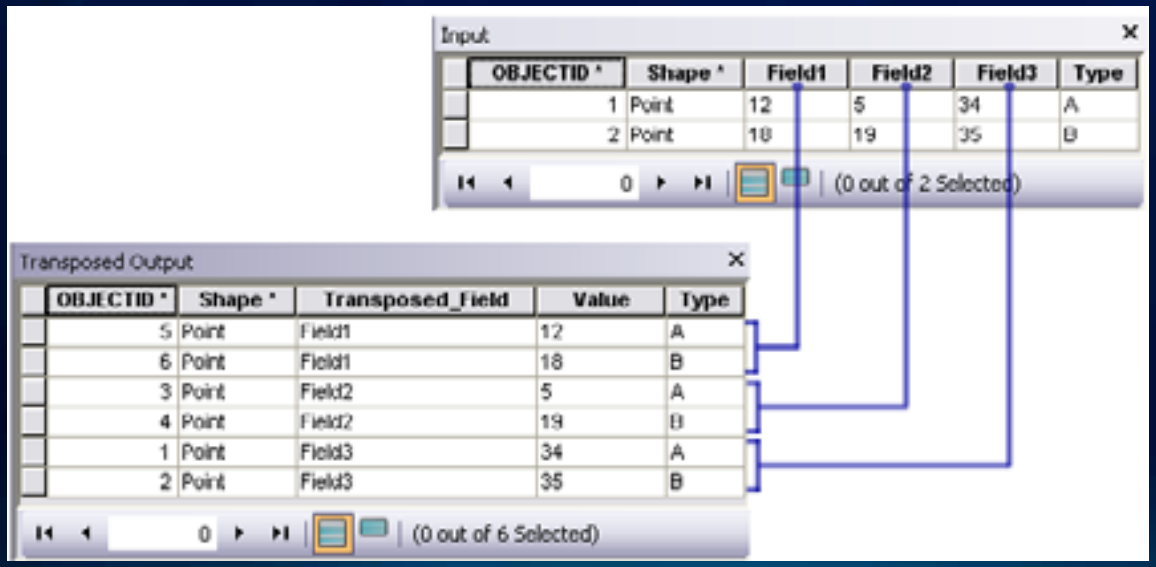
- **Use a date/time field**
- **Use an index field (i.e. ObjectID)**

OBJECTID*	NAME	Shape*	Raster	Date_Time	SHAPE_Length	SHAPE_Area
1	Image1.gif	Polygon	Raster	1998-10-14 12:00:00	3068	522753
2	Image2.gif	Polygon	Raster	1998-10-15	3068	522753
3	Image3.gif	Polygon	Raster	1998-10-15 12:00:00	3068	522753
4	Image4.gif	Polygon	Raster	1998-10-16	3068	522753
5	Image5.gif	Polygon	Raster	1998-10-16 12:00:00	3068	522753
6	Image6.gif	Polygon	Raster	1998-10-17	3068	522753
7	Image7.gif	Polygon	Raster	1998-10-17 12:00:00	3068	522753

- **Note: The layer will initially draw as a wire frame if more than 9 rasters.**

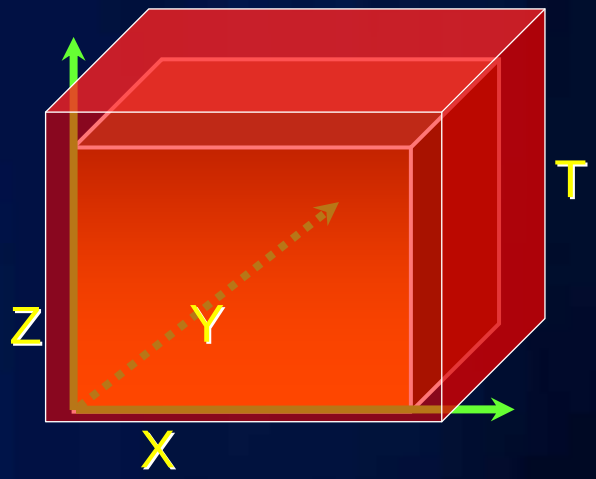
What if time is stored in columns?

- ArcGIS works with time stored in records, not columns
  - Need to transpose data in columns into records
  - Reformat table with Transpose Fields GP tool



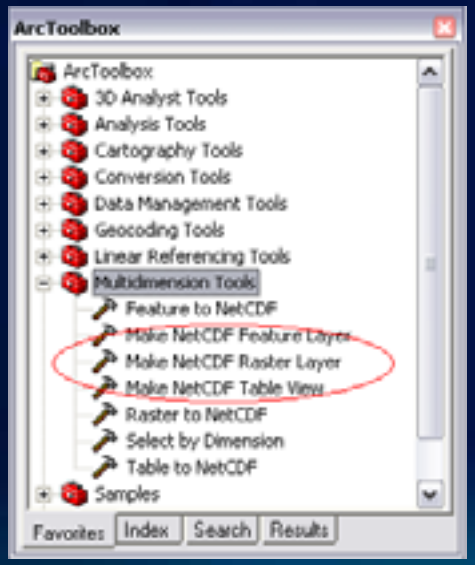
Supported Data - NetCDF data

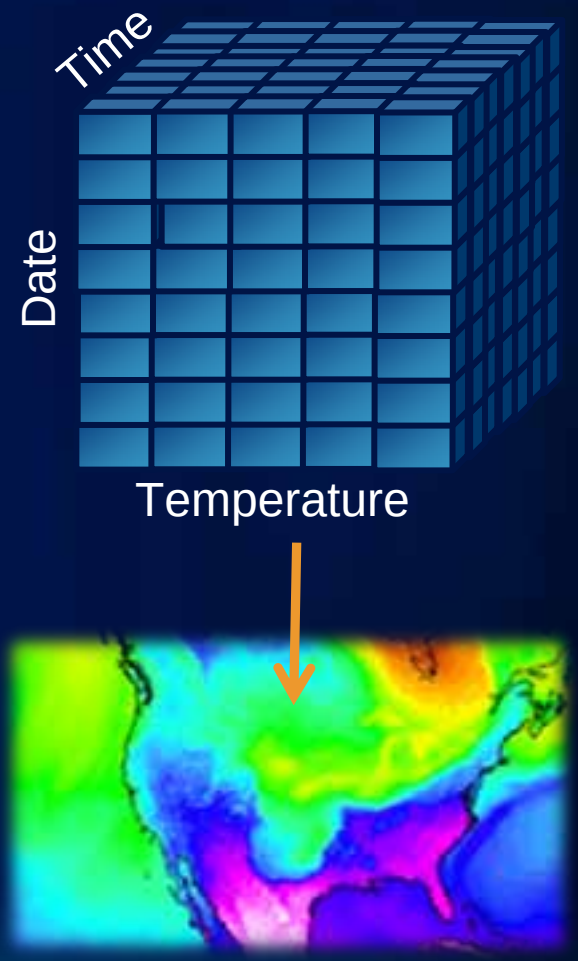
- An array based data structure for storing multidimensional data.
- N-dimensional coordinates systems
  - X coordinate (e.g. longitude)
  - Y coordinate (e.g. latitude)
  - Z coordinate (e.g. altitude)
  - Time dimension
  - … other dimensions
- Variables – support for multiple variables
  - Temperature, humidity, pressure, salinity, etc



NetCDF Layers and Table

- Make a layer or table from the NetCDF file
- Choose the dimension to visualize through ????
- Multidimension GP Tools





Time Zones

Source: wikipedia.org

Time Zones

- ArcGIS integrates data across different time zones

- If possible, standardize on UTC (or GMT)

- What if your data is across different time zones?
- GP tool – Convert Time Zone

Daylight Savings Time

- Problems with DST
  - Regional differences – political disagreement on DST
  - Some DST zones adjust less than an hour
    - 30 minute and 45 minute DST offsets
  - Evolving definitions (US DST rules changed in 2007)

- Store timestamps as Standard Time (not DST)

Managing Temporal Information in ArcGIS - Demonstration

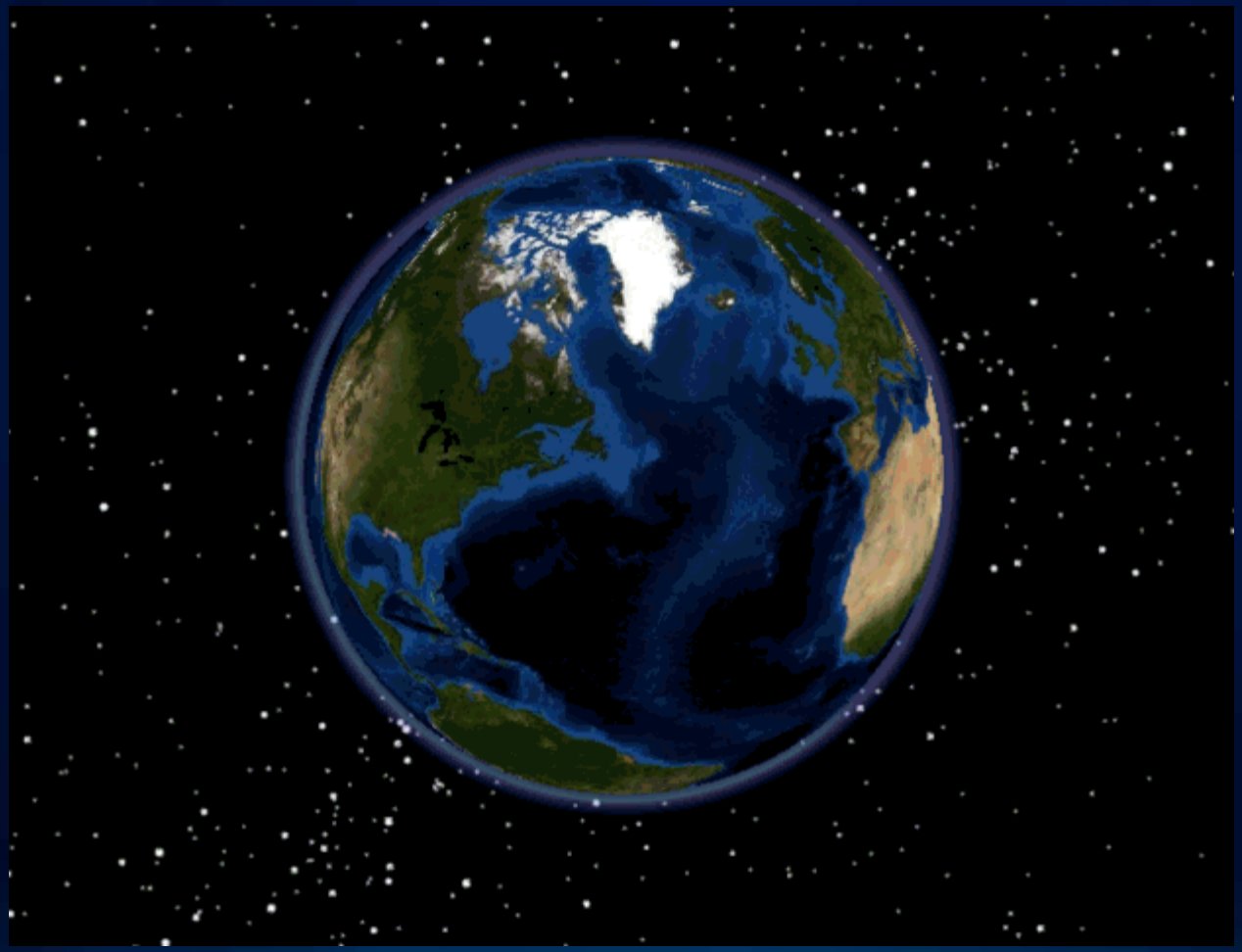
Temporal Data Visualization

Time Animations

- Use Time Animation for creating dynamic visual effects
  - Visualize temporal data while flying over an area
  - Fading in/out layers while visualizing temporal data
  - Visualizing time enabled layers at different time steps
- Existing ArcGIS 9 Time Layer Animations
  - Should work automatically in ArcGIS 10
  - Time properties on layers are set automatically

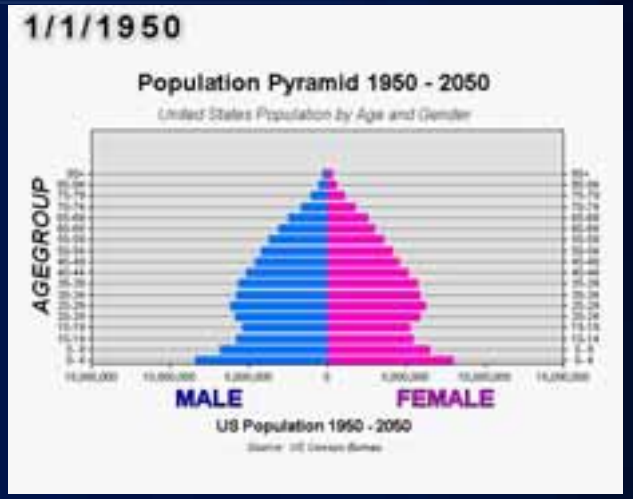
- Note - If you just want to visualize data over time, use the Time Slider

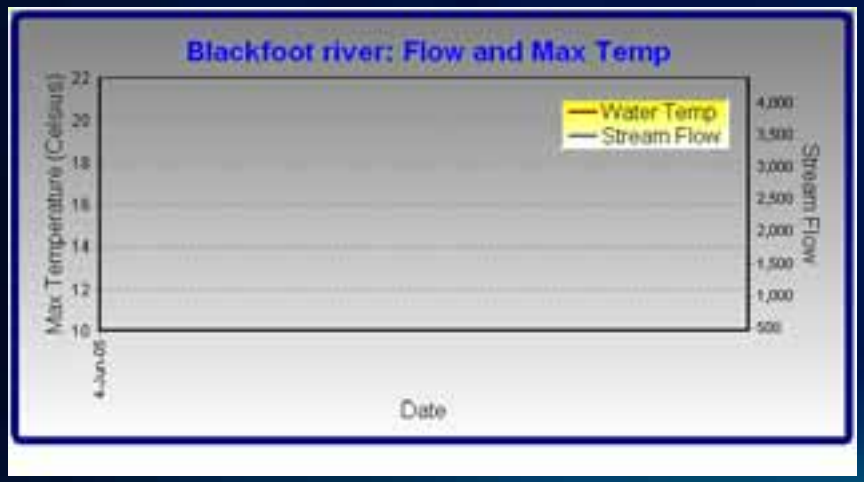
Animation – “Fly Over” plus Time Progression



Animating data in graphs

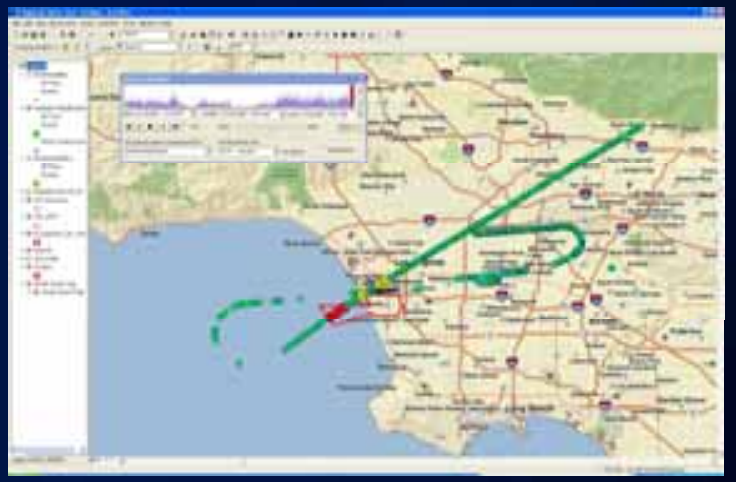
- *Create a graph using a layer or table*
- Create an animation in the usual way, attaching the layer or table to a time layer track
- When the animation is played, the graph will animate





ArcGIS Tracking Analyst and Tracking Server

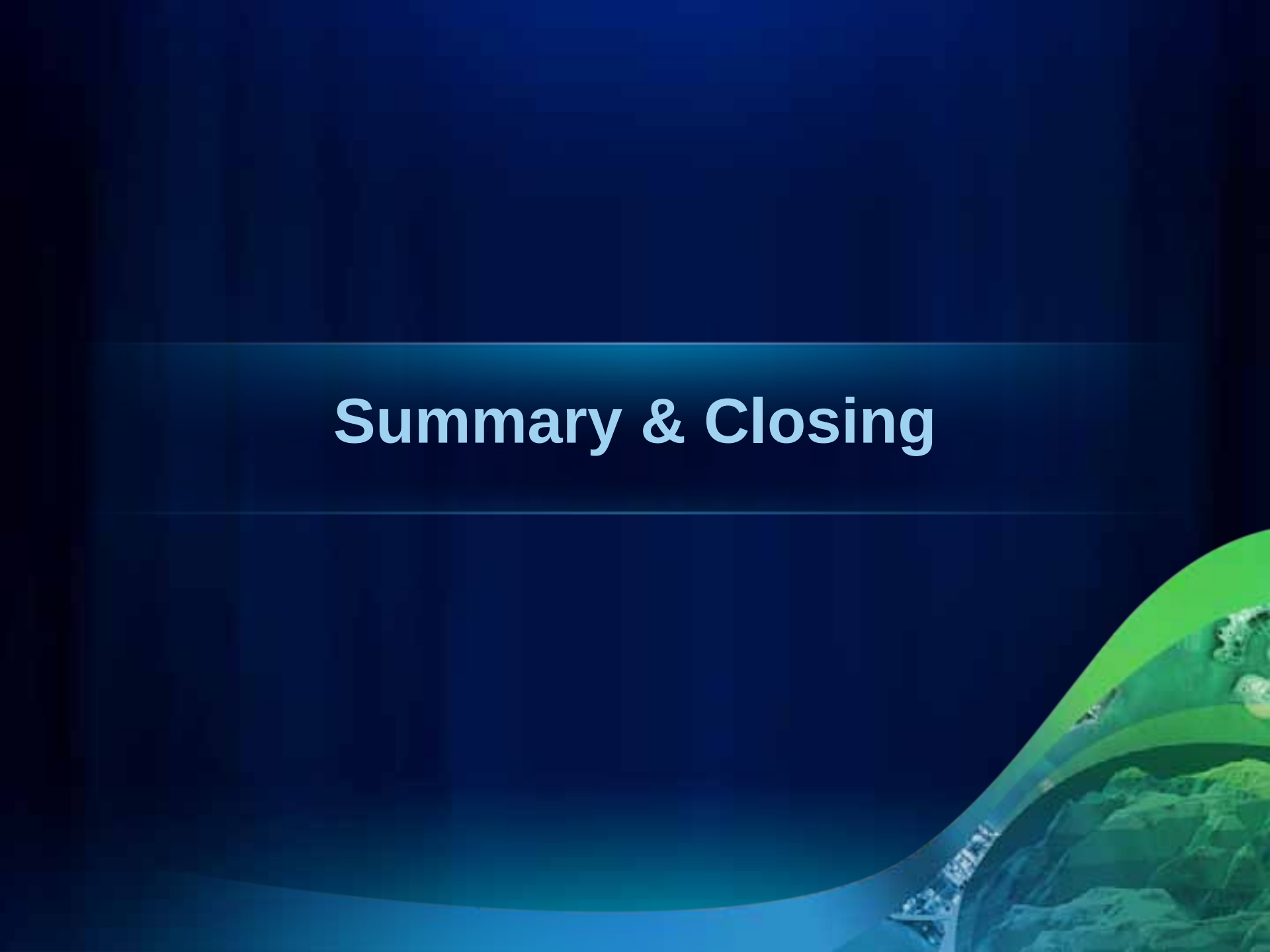
- Collect and Monitor real-time data
- Visually organize point data into track lines
- Analyze change over time - Aging of color, size, shape
- Per-feature analysis
  - GeoFencing
  - Filtering



Enabling Real-Time Temporal GIS Solutions

Temporal Data Visualization Demonstration

Summary & Closing



Summary of Best Practice Recommendations

- Use DATE field type whenever possible
- Database Index on the DATE field
- UTC (or GMT) for time zone
- Use Standard Time – avoid Daylight Savings (DST)
- Use Data Conversion tools to convert to supported field types and storage formats
- Know when to model with single vs. join tables

What's coming in ArcGIS 10.1?

- Live mode on the Time Slider
  - Allows you to visualize the most recent updates to time-enabled data
- Space time clustering using Spatial Statistics GP tools
- Time text displayed in the map view
  - For embedding time in the exported videos or sequential images
- Time window improvements
  - Data being displayed twice in consecutive time windows
  - Options to exclude or include data at the start and end time of a specified time window

Questions?

- **Contact Us:**
  - **David Kaiser** dkaiser@esri.com
  - **Hardeep Bajwa** hbajwa@esri.com

- **Please complete an online session evaluation:** www.esri.com/sessionevals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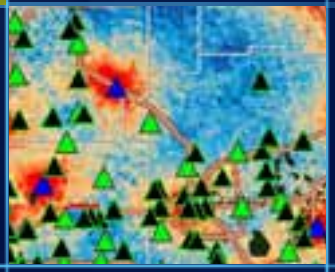


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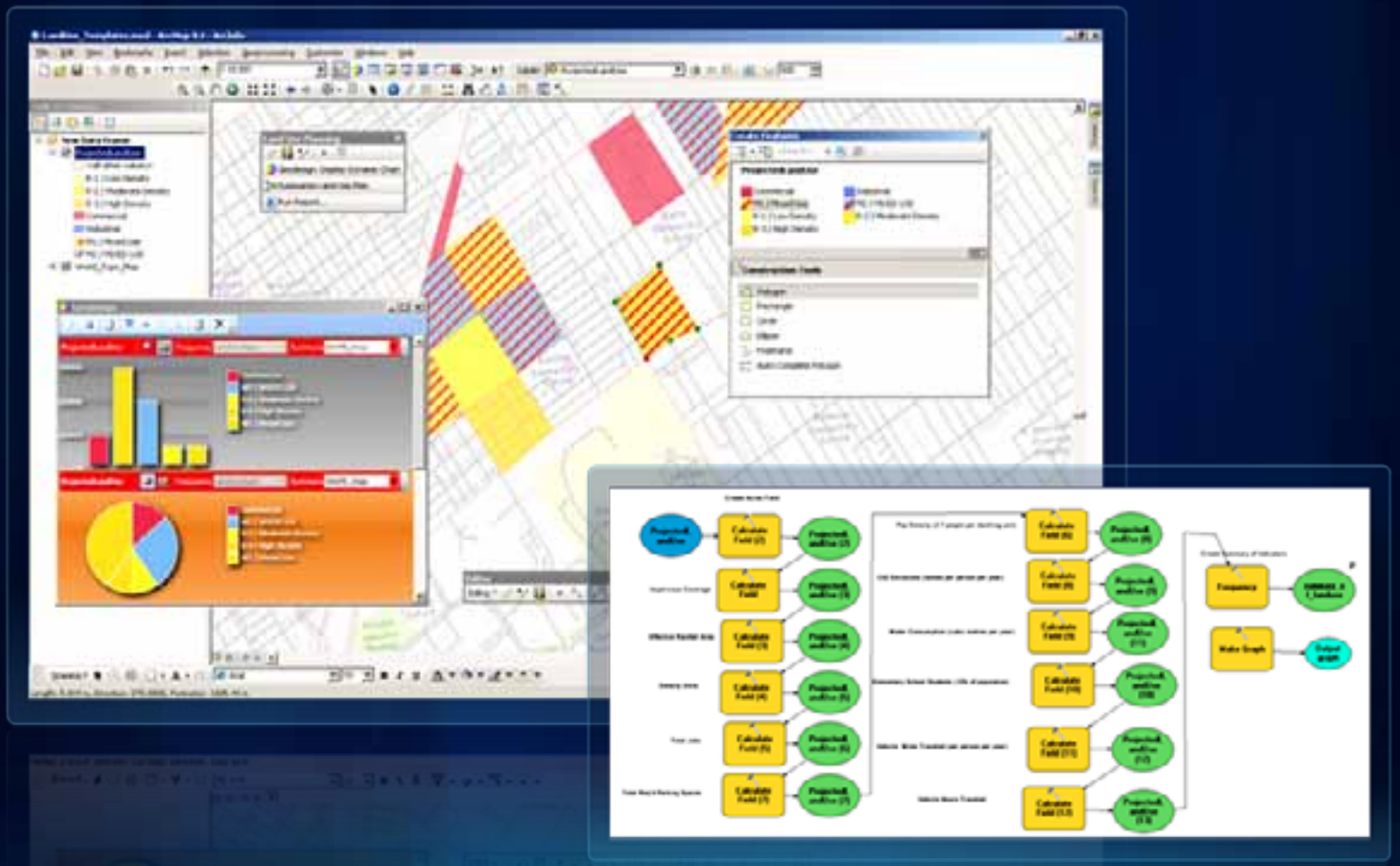
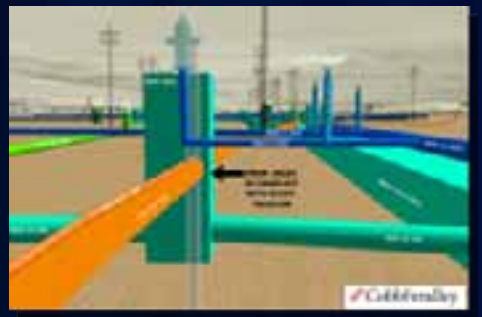
Sample Maps

Sample Screenshots Layout *(preferred)*



Sample Screenshots Layout

Underground Utilities



Texas

Utility Network

Germany

University

Pennsylvania

Building/Room

Panama

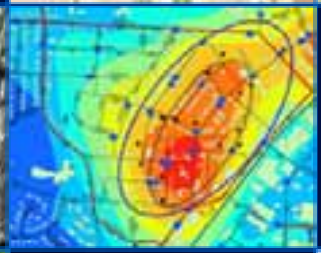
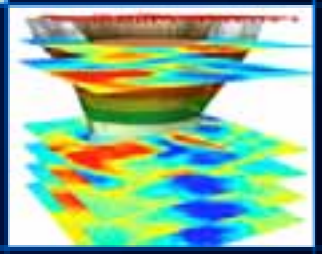
Railroads

Switzerland

Oil Platform

Norway

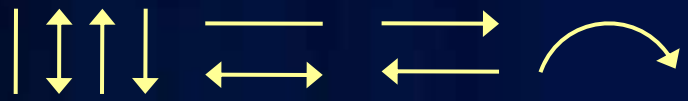
Grids for Images/Screenshots (may ask designer for assistance)

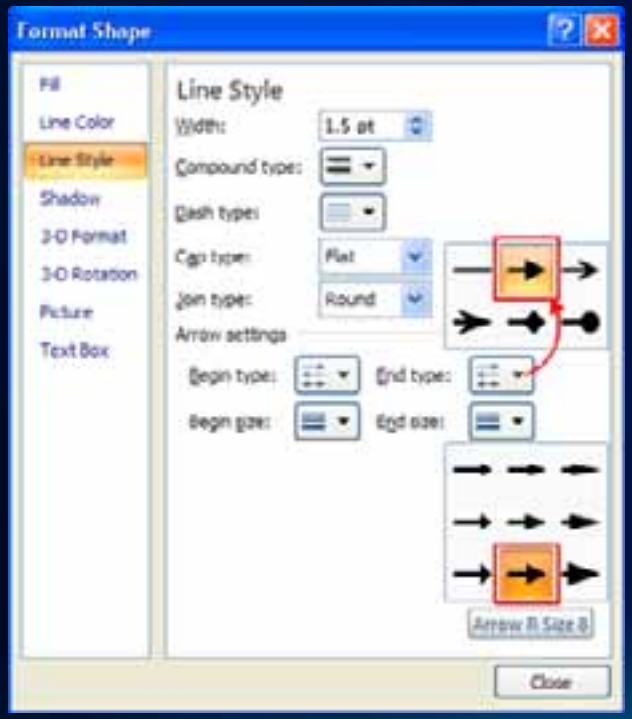
environmental conservation				
				disaster response
			demographic analysis	

Diagrams/Icons

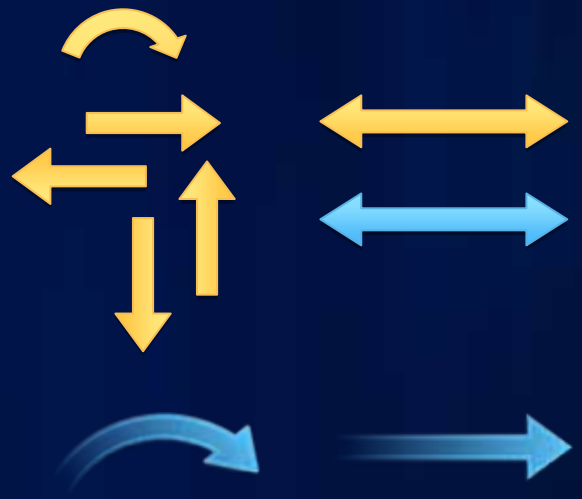
Arrows

Arrows for Connecting Items





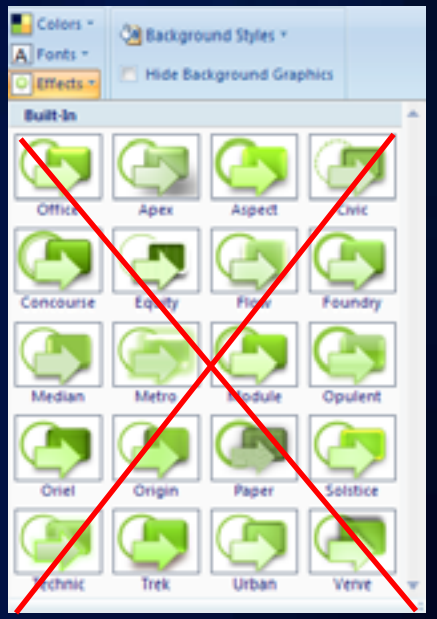
Arrows for Connecting Large Concepts



Shapes for Diagrams

Quick Style: Subtle Effect	Quick Style: Moderate Effect
ArcGIS	ArcGIS
ArcGIS	ArcGIS
ArcGIS	ArcGIS
ArcGIS	ArcGIS
ArcGIS	ArcGIS
ArcGIS	ArcGIS

DON'T APPLY EFFECTS from the Design tab

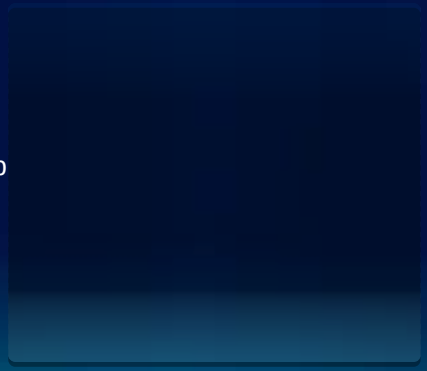


Shapes for Diagrams *(continued)*

Cloud optimized for use behind diagrams

Cloud for general diagram

Circle behind a group of objects



Content box for each tier (see sample diagrams)

Optional: Use as a frame around showcased screenshots

Sample Diagrams

ArcGIS Implementations

Desktop

Individuals

- Ad Hoc Projects
- Analysis/Modeling
- Mapping

Server

Workgroups

- Shared Database
- Fixed Applications
- Transactions

Enterprise

Organizations

- Shared Services
- Integration
- Collaboration

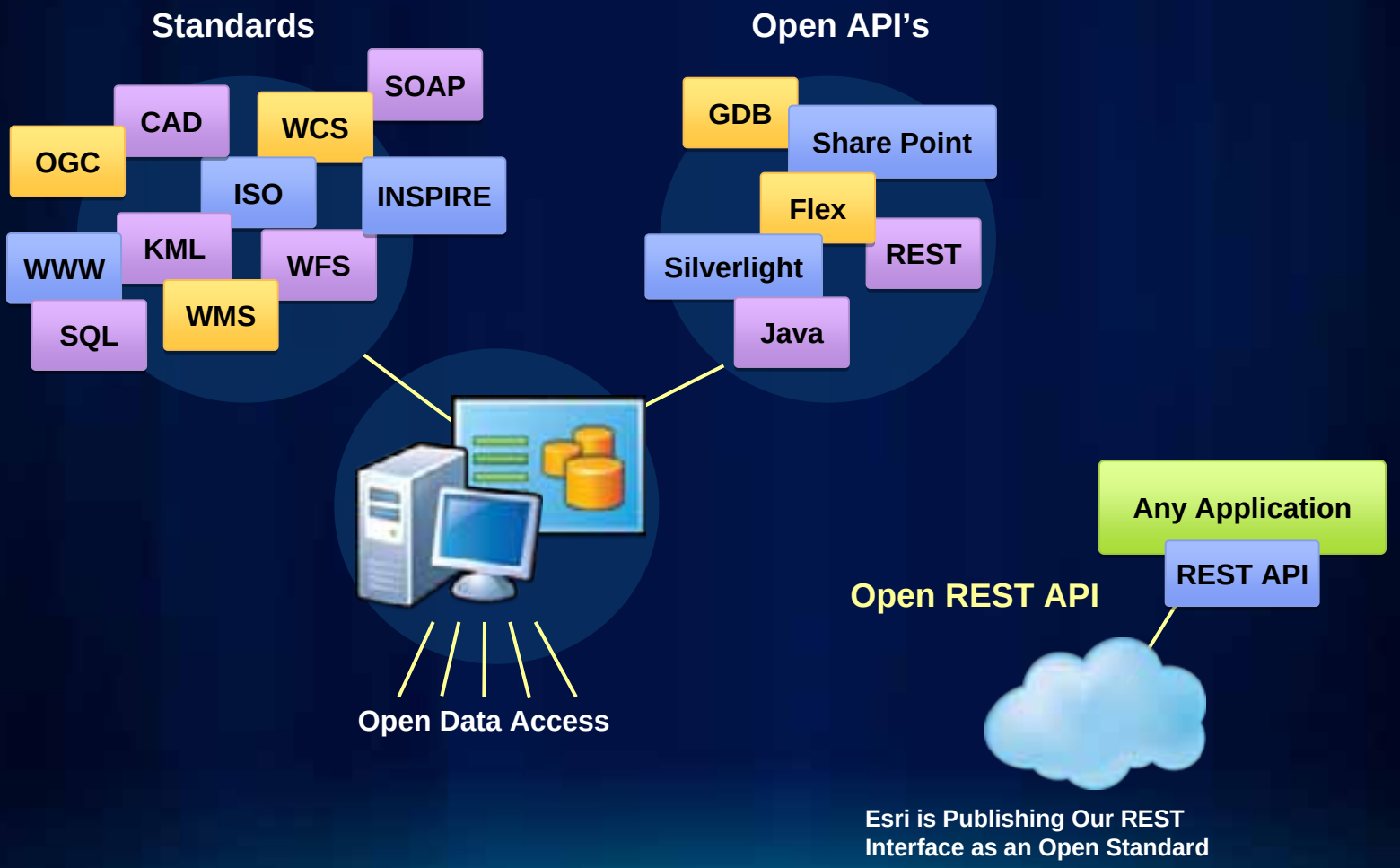
Web GIS

New

ArcGIS 10 — A Complete System

Easier
More Powerful
and Everywhere

Quick Style — Moderate Effect



Access the Entire Icon Library

Over 160 items added in 2010

- **430 total icons available for Esri use**
- **Browse and search from any Microsoft Office application**
- **Accessible when you're connected to the Esri Network**
- **Also available offline as directories of PNG files**
- **See the presenter notes below for details**

A Selection of Frequently Used Icons


ArcGIS Desktop


ArcGIS Online


Web Blog


Web Blog


Mashups


Mashups

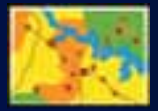

Browser


Open Standards


ArcGIS Desktop Authors


Web Map


Web Map


Map


Web Map


Map

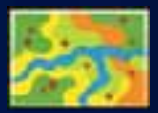

Web Map


Map


Raster Files


Raster Files


Web Map


Map


Web Map


Map


Web Map


Map


Web Map


Map

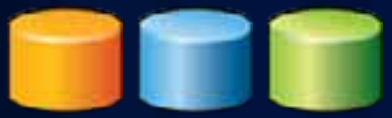

Web Map


Map

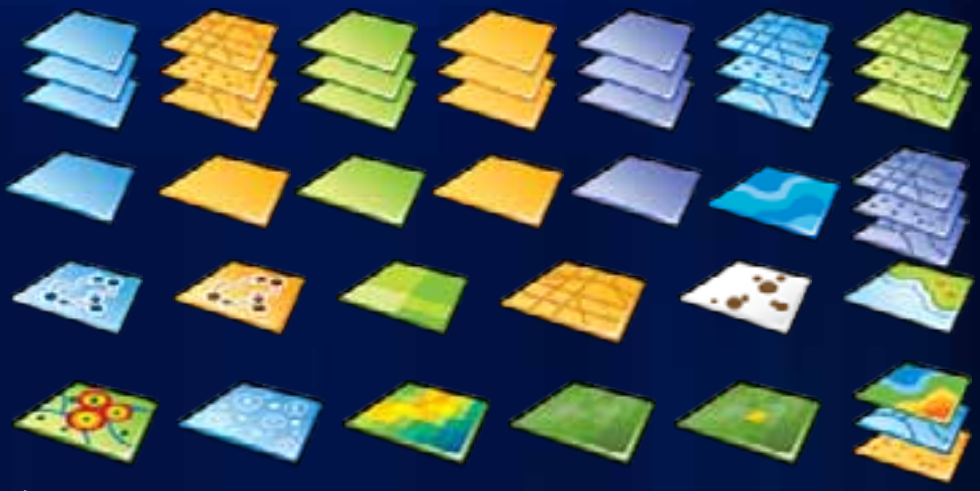

Explorer


Web Map

Globes



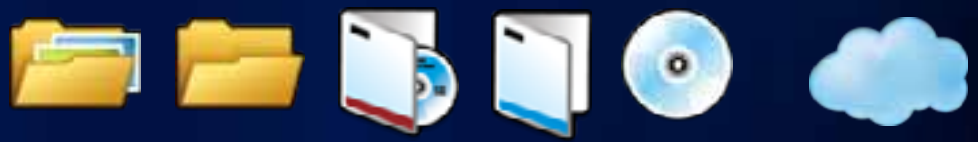
Databases



Layers

Files

Table



Files

CD/DVD

Internet/Cloud

Legend

Network

Models


Designing
& Planning
Situational Awareness
Professional Services
Professional
Services
Education
Education
Business
Partner
Mobile GIS User
GIS User


Data Server
Data Appliance
GIS Users
Geodatabase
Web GIS
Mashups

.75”

Title Safe Area — Please Read

1”

1”

This area is the **title safe area** (10% in from each slide edge).
All text and graphics should be contained within this area to prevent loss during transmission and reproduction.

Any information outside the title safe area runs the risk of being cropped off when captured to video.

Please note the adjusted title and body template styles adhering to the title safe area. Presenters will need to adjust their slides accordingly as needed to reposition text and graphics.

Right-click and select Grid and Guides
Check "Display drawing guides on screen”

.75”

Successful Presentation Guidelines

- **Know your target audience**
- **Use slides to lead not read**
  - **Use a key phrase or a few words**
  - **Avoid more than two levels of bullet points**
- **Use title slides for each section**
  - **Make it clear where you are going**
- **Avoid too much animation—Keep it simple!**

Additional ESRI presentation resources available on ArcZone
http://arczone/resources/presentations.cfm

Migrating to the New Template

This template was rebuilt from scratch and fixes problems found in previous versions.

- **Download the instructions and support files from** http://arczone/resources/presentations.cfm

Color Guidelines

Color Swatches

Use Esri 2011 as theme colors

(see presenter's notes for the instruction of how to add the Esri theme and theme colors)

Projector Color Guidelines

Use the sRGB video mode on the projector. Most projectors have this setting.

Additional ESRI presentation resources available on ArcZone
http://arczone/resources/presentations.cfm