Outline

• Introductions

• The Model
  • History, The Future, Objectives, Present
  • Core Elements
    • Station Series, Control Points, Stationing
    • Model Objects
  • Tour of the Model
    • Centerline, Facility, Inspection, Operations, Cathodic, Event Support

• Implementation Issues

• Questions and Answers
The Model

• A template with core tables and attributes
• Core elements are absolute
• Rest of model is totally configurable & customizable
• Designed to be implemented as ESRI GeoDatabase
• Can be an ‘event-based’ or ‘feature-based’ model
History

- ESRI Pipeline Interest Group (PIG)
- PIG Technical Committee
- 1 year of effort (March 2002)
- 7 meetings since August 2002
- Utilize the common/best elements of published pipeline models (PODS/ISAT)
- 75 Feature Classes to 45 Feature Classes
- Developed for ESRI GeoDatabase
History

- Technical Committee Members:
  - Scott Hills – Chevron Texaco
  - Theo Lawrence – Great Lakes Gas Trans.
  - Tom Marcotte – James Sewall Company
  - Buddy Nagel – El Paso Corporation
  - David Nemeth – Southern Union Panhandle
  - Lane Powell - ESRI
  - Jay Smith – M.J. Harden Associates Inc.
  - Fred Spickler – PhotoScience Inc.
  - Tracy Thorleifson – Eagle Information Mapping
  - Peter Veenstra – M.J. Harden Associates Inc.
Future

- Designed for ArcGIS 8.2
- Version 1.0 Beta released now
- Focus on ArcGIS 8.3 until July 2003
  - Topology
  - Advanced Linear Referencing Tools
- Version 1.0 released at ESRI UC 2003
- Two review sessions yearly (EGUG and PUG)
The Model – Objectives

- Common framework for implementing Transmission Pipeline GeoDatabases
- Handle linear referencing (Stationing)
- Handle absolute positioning (X,Y)
- Utilize ESRI Technology
  - Routes, measures, events, feature classes, subtypes, relationship classes, domains etc.
- Develop starting place
  - For organizations to build models
  - For vendors to develop applications
The Present

• Huge variation in how data is modeled from pipeline company to pipeline company

• Model developed according to two guidelines:
  • What do 80% of pipeline companies require
  • What is absolutely required by government regulations (FERC, DOT, etc.)

• Model presented for review

• Need feedback
  • What is missing – technology, implementation?
Core Model

- Station Series
- Control Points
- Stationing
- Model Objects
  - Online Referenced Networked
  - Online Referenced Non-Networked
  - On or Offline Referenced
  - Not Referenced
  - Object Class
  - Core Elements
Core Model: Station Series

- Connected linear features
- Contain stationing information
- Station Series = Route
- Station Equations
- All referenced features relate to one and only one Station Series (Route)
- Participate in Geometric Network with control points
Core Model: Station Series

Introduction

History

Future

Objectives

Present

Model Tour

Implementation

Q & A

Core

Station Series 1 (Route)

Station Equation

Station Series 2 (Route)

StationSeries

(GeometryType = esriGeometryPolyline,
 HasM = True,
 HasZ = False)

-EventID : esriFieldInteger
-Hierarchy1 : esriFieldString
-Hierarchy2 : esriFieldString
-Hierarchy3 : esriFieldString
-LineLoopEventID : esriFieldInteger
-SeriesType : roStationSeriesPipeType = 1
«SubtypeField» -SubTypeCD : esriFieldInteger = 1

Subtypes:: Series

-SubTypeCD : esriFieldInteger = 1

ArcGIS Pipeline Data Model
Core Model: Control Points

- Point feature representing:
  - Known XY location (GPS, Monument, Line Crossing)
  - Known stationed position (Historic Stationing)
  - Point of Inflection (Horizontal/Vertical bend)
- Control Points are vertices and end points of station series
- Subtyped as: End Points or Internal Points
- Each control point has one or more station values associated with it
Core Model: Control Points

ControlPoint
(AncillaryRole = esriNCARNone,
 GeometryType = esriGeometryPoint,
 HasM = False,
 HasZ = False)

- ControlPointAngle : esriFieldTypeString
- ControlPointType : roControlPointType = 1
- EventID : esriFieldTypeInteger
- PIDirection : roControlPointDirection = 1

Subtypes:
- InternalPoint -SubTypeCD : esriFieldTypeInteger = 1
- EndPoint -SubTypeCD : esriFieldTypeInteger = 2

Subtypes:
- InternalPoint

End Point

Internal Point

Internal Point

Internal Point

End Point

End Point

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ESRI Petroleum User Group 2003

ArcGIS Pipeline Data Model
Core Model: Stationing

- Stored in object class (ITable)
- Station values along station series (measures along route) at a single control point
- Relates to one station series and one control point
- A control point can have one or more station values
Core Model: Stationing

```
ControlPoint
{AncillaryRole = esriNCARNone,
GeometryType = esriGeometryPoint,
HasM = False,
HasZ = False}

StationSeries
{GeometryType = esriGeometryPolyline,
HasM = True,
HasZ = False}
```

```
Event_Support::Stationing
-ControlPointEventID : esriFieldTypelnteger
-EventID : esriFieldTypelnteger
-StationSeriesEventID : esriFieldTypelnteger
-StationingType : roReferenceMeasureType = 1
-StationingValue : esriFieldTypedouble = 0.00
```

```
ControlPoint
{ControlPointAngle : esriFieldTypeString
ControlPointType : roControlPointType = 1
EventID : esriFieldTypelnteger
PDIrection : roControlPointDirection = 1

«SubtypeField» -SubTypeCD : esriFieldTypelnteger = 1
```

```
StationSeries
-EventID : esriFieldTypelnteger
-Hierarchy1 : esriFieldTypestring
-Hierarchy2 : esriFieldTypestring
-Hierarchy3 : esriFieldTypestring
-LineLoopEventID : esriFieldTypelnteger
-SeriesType : roStationSeriesPipeType = 1

«SubtypeField» -SubTypeCD : esriFieldTypelnteger = 1
```

```
Event_Support::Stationing
+FieldType = esriFieldTypelnteger
+MergePolicy = esriMPTDefaultValue
+SplitPolicy = esriSPTDefaultValue
+As-Built Slope-Chain Station = 1
+As-Built Horizontal Station = 2
+Milepost based on Slope-Chain Station = 3
+Milepost based on Horizontal Station = 4
+3D Distance from Beginning of Discharge = 5
+Engineering Stationing = 6
+Unknown = 7
```

```
«CodedValueDomain»
Centerline_Domains::roReferenceMeasureType
+FieldType = esriFieldTypelnteger
+MergePolicy = esriMPTDefaultValue
+SplitPolicy = esriSPTDefaultValue
+As-Built Slope-Chain Station = 1
+As-Built Horizontal Station = 2
+Milepost based on Slope-Chain Station = 3
+Milepost based on Horizontal Station = 4
+3D Distance from Beginning of Discharge = 5
+Engineering Stationing = 6
+Unknown = 7
```

```
«GeometricNetwork»
Routing_GeoNet
-NetworkType : esriNetworkType = esriNTUtilityNetwork
```
Core Model

- All features in GeoDatabase are one of six defined model types
- All referenced features must relate to a station series feature for relative positioning
- Features have inherent absolute position
- Events are generated solely on relative position
- All ‘events’ or ‘features’ must have globally unique identifier: EventID
- EventID is used for all relates.
Core Model: Model Objects

- Online Referenced Networked (ORN)
  - Point
    - `StationSeriesEventID, Station`
  - Line
    - `Begin/EndStationSeriesEventID, Begin/End Station`

- Online Referenced Not-Networked (ORNN)
  - Point/Line
    - As above

- On or Offline Referenced (OOR)
  - Point
    - `OffsetDistance, OffsetAngle, OffsetSide`
  - Line
    - `Begin/End Offset – Distance/Angle/Side`

- Not Referenced (NR)
Core Model: Definitions

- Referenced – position on or along the centerline can be determined by station series and station value
- Online – feature or event is ‘geometrically constrained’ to the edge of a station series feature
- Networked – online referenced feature that participates in Geometric Network
- Offline – referenced feature that is located off of the centerline
Core Model: ORN

- Online Referenced Networked Feature
- Point or Linear Feature
- Geometrically constrained to centerline
- Begin/End position located by stationing
- Participates in a Geometric Network
  - *Pipes, Valves, Reducers, Closures*
Core Model: ORNN

- Online Referenced Not-Networked
- Point or Linear Feature
- Geometrically constrained to centerline
- Does not participate in Geometric Network
  - *Leaks, Pressure Tests, Coating*
Core Model: OOR

- On or Offline Referenced
- Point or Linear Feature
- Usually exists off the centerline
- Does not participate in Geometric Network
  - Structures, Ground Beds, HCA Areas
Core Model: Other

- Not Referenced
  - Pass-through Polygons, Transportation Networks, Hydrology, Environmental, Operational, and Cultural features

- Object Classes
  - Activities, External Documents, GeoMetaData, Contacts, Companies etc.
Tour of the Model

• Model comprised of logical grouping of FeatureDataSets:
  • Centerline – routing and stationing
  • Facility – pipes, valves and other fittings
  • Inspection – inspection ranges, anomalies, leaks
  • Operations – pressure tests, risk analysis, HCA
  • Cathodic – cathodic protection features
  • Event Support – administrative, activities, history, documentation and comments
  • Subtypes, Relationship Classes and Domains
**Model Tour: Centerline**

- Objects that form the centerline
- Linear Referencing Mechanism
- Form Routing Geometric Network
  - *StationSeries (PLFc)* – routes of stationing, contains hierarchy information
  - *ControlPoint (PtFc)* – points of known station position, PI’s
  - *LineLoop (OC)* – a collection of station series that comprise a single ‘line’
  - *GeoMetaData (OC)* – source information for control points
  - *OwnerOperatorship (OC)* – Line Loop owner/operator percentages
Model Tour: Facility

- Physical elements that comprise Pipeline
- Typically form Geometric Network
- Online Referenced Not Networked
  - Coating (PLFc), Sleeve (PLFc), Casing (PLFc), Appertenance (PtFc), Vessel (PtFc)
- Not Referenced
  - NonStationedPipe (PLFc), PiggingStructure (PLFc)
- Online Referenced Networked
  - Pipe Segment (PLFc), Valve (PtFc), Fittings (Meter, Elbow, Tee, Reducer, Closure) (PtFc), PipeJoinMethod (PtFc), Tap (PtFc)
**Model Tour: Inspection**

- Inspection and Integrity
- Generic classes
- Huge variance in applications and data
- Does not form GeoMetric Network
  - Online Referenced
    - Anomaly (PtFc) – anomaly or deformity in pipe
    - AnomalyCluster (mPtFc) – cluster of anomalies
    - InspectionRange (PLFc) – linear inspection – eg. Leak Survey, Inline PIG Run, Aerial Survey, Close Interval Survey
Model Tour: Operations

- Regulatory and Operations
- Does not form Geometric Network
  - On or Offline Referenced
    - FieldNote (PtFc) – Field Data Collection
    - ElevationPoint (PtFc) – ground, pipe water elevations
    - Marker (PtFc) – monuments, Mile Posts, PIG Signals
  - Not Referenced
    - SiteBoundary (POFc) – Meter Stations, Compressor Stations, Easements etc.
  - Online Referenced
    - HCAClass (PLFc), PressureTest (PLFc), RiskAnalysis (PLFc), OperatingPressure (PLFc), RightOfWay (PLFc)
Model Tour: Cathodic

- Corrosion Management
- Kept generic
- Based on Distribution Model
- Not Geometric Network
  - On or OffLine Referenced
    - CPRectifier (PtFc)
    - GPGroundBed (PtFc)
    - CPAnode (PtFc)
    - CPBond (PtFc)
    - CPTestStation (PtFc)
  - Online Referenced
    - CPCable (PLFc)
Model Tour: Encroachments

- Encroachments on the pipeline
- Encroachments within the Class Corridor
- Does not form Geometric Network
  - Not Referenced
    - HighConsequenceAreas (POFc), StructureOutlines (POFc)
  - Online Referenced
    - LineCrossing (PtFc)
  - On or Offline Referenced
    - LinearEncroachment (PLFc), Structure (PtFc)
Model Tour: Event Support

• Object Classes to support:

  • History, Mapping, Documentation
    • Activity (OC) – any activity that occurs
    • ActivityEvents (OC) – events that are part of an activity
    • AlignmentSheet (POFc) – sheet boundary and info
    • Company (OC) – companies, contractors, divisions
    • Contact (OC) – any person in the system
    • DataSet (OC) – FeatureDataSet MetaData
    • DocumentPoint (OC) – multi-hyperlinked feature
    • ExternalDocument (OC) – source document links
    • GeoMetaData (OC) – point source meta data
    • RemovedLine/Point (PL/PTFc) – removed features
    • LastEventID (OC) – holds the last EventID
Model Tour: GeoDB

• Subtypes
• Relationship Classes
• Domains
Model Tour: Missing?

- Landbase – Parcels
- Operations – Class Corridors
- Fittings – make them ORN features
- Integrity – different data formats from PIG runs
- Cathodic – variance between companies
- Inspections – Readings, Surveys – what belongs in the GIS and what in RDBMS?
Implementation Issues

• Event and/or Feature approach
• Getting Data into the Model
• Future Documentation
Points to Remember

• Utilize GeoDatabase and GIS to fullest capability
  • Parcels, Transportation Networks, Land Survey, Political Boundaries can exist as feature classes in model – powerful analysis tool
• No model can be everything to everyone
  • Choose what your GIS implementation is going to solve and create a suitable model
• Utilize the core elements to handle linear referencing
• Test potential classes against ORN, ORNN, OOR, NR and Centerline class types
Downloading

- Building the GeoDatabase
  - Error building the model – Schema Wizard Bug

- [www.esri.com\petroleum](http://www.esri.com\petroleum)
- [www.esri.com\datamodels](http://www.esri.com\datamodels)
Questions and Answers
Contact Information

• Andrew Zolnai – Petroleum Manager – ESRI azolnoi@esri.com

• Peter Veenstra – Chairperson APDM Technical Committee – M.J. Harden Associates – pveenstra@mjharden.com

• Any member of the PIG Steering and Technical Committees
Thank you.