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Author: Henry Kucera, Gail Kurcera
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Developing Standards for Time-varying Spatial Information

Discussion Paper

DRAFT

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Henry Kucera
Gail Kucera

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Executive Summary

This document proposes an approach to develop the standards required to treat time-varying information. The intended audience of this document is the ISO TC211 Committee members and other relevant standards groups, specification consortia, and software developers who will implement products based on the schema.

The key business driver is to be more realistic and comprehensive in the representation and analysis of geospatial information, and to improve our understanding of geographic situations—in the past, present, and future. The existence of standards will improve the flow of time-varying geospatial information among interested parties, and thereby provide a more complete picture within which to analyze trends, patterns, deviation from trends or patterns, causality, and other indicators of interest.

The proposed development approach is to: 1) fast-track an application schema for moving features, and 2) initiate a Stage 0 Project to assess requirements and approaches for a comprehensive schema for time-varying geospatial information.

The rationale for fast-tracking moving features is that they are well-understood and there is broad interest in achieving a standard to be used by such business areas as Location-Based Services (LBS), Intelligent Transportation Systems (ITS), wildlife management, military and intelligence applications, humanitarian aid, and modeling and simulation. It is imperative that the core conceptual model for moving features be shared among all interested parties to ensure proper interfaces between market areas. The work to develop an application schema for moving features will generate constructive discussion and terminology that will be useful in the parallel effort to develop more comprehensive standards.

The rationale for undertaking a Stage 0 Project to define a comprehensive approach to time-varying geospatial information is that many challenges exist, and to reach consensus will require more time. During the course of the Stage 0 Project, it is likely that additional capability can be identified for fast-tracking.

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1 Introduction

A standardized conceptual schema for time-varying information is needed to improve the ability to share geographic information among applications, and across enterprise implementations. Software and application developers will use this schema to design technology with enhanced capability to manage and analyze information about changes to real-world phenomena and modeled phenomena.

The key business driver is to be more realistic and comprehensive in the representation and analysis of geospatial information, and to improve our understanding of geographic situations—in the past, present, and future. The existence of standards will improve the flow of time-varying geospatial information among interested parties, and thereby provide a more complete picture within which to analyze trends, patterns, deviation from trends or patterns, causality, and other indicators of interest.

The Spatial Schema (ISO 19107) and Temporal Schema (ISO 19108) provide core capability to describe geospatial information, and to locate geospatial features or objects in time. The capability to describe change over time is less complete, however, and options for implementation are extremely open-ended, to a degree that could impede interoperability. Standardized application schemata are needed for specific uses. The application schemata must be backward compatible with 19107 and 19108. And the application schemata for common feature types should be harmonized among the business areas that use them.

1.1 Purpose of this document

This document proposes an approach to develop the standards required to treat time-varying information. The intended audience of this document is the ISO TC211 Committee members and other relevant standards groups, specification consortia, and software developers who will implement products based on the schema.

1.2 Synopsis of proposed approach

The proposed development approach is to: 1) fast-track an application schema for moving features, and 2) initiate a Stage 0 Project to assess requirements and approaches for a comprehensive schema for time-varying geospatial information.

The rationale for fast-tracking moving features is that they are well-understood and there is broad interest in achieving a standard to be used by such business areas as Location-Based Services (LBS), Intelligent Transportation Systems (ITS), wildlife management, military and intelligence applications, humanitarian aid, and modeling and simulation. It is imperative that the core conceptual model for moving features be shared among all interested parties to ensure proper interfaces between market areas. The work to develop an application schema for moving features will generate constructive discussion and terminology that will be useful in the parallel effort to develop more comprehensive standards.

The rationale for undertaking a Stage 0 Project to define a comprehensive approach to time-varying geospatial information is that many challenges exist, and to reach consensus will require more time. During the course of the Stage 0 Project, it is likely that additional capability can be identified for fast-tracking.

1.3 Use of terminology

The following terminology is used in this document.

- Application Schema - conceptual schema for data required by one or more applications (19101).
- Feature - an abstraction of real-world phenomena (19101).
- Feature Association - relationship that links instances of one feature type with instances of the same or a different feature type (19109).
- Feature Attribute - a characteristic of a feature (19101). A feature attribute may occur as a type or an instance. Feature attribute type or feature attribute instance is used when only one is meant (19109). A feature attribute type has a name, a data type and a domain associated to it. A feature attribute instance has an attribute value taken from the domain of the feature attribute type (19109).
- Feature Division – a form of feature succession in which a previously existing feature is replaced by two or more distinct feature instances of the same feature type (19108).
- Feature Fusion – a form of feature succession in which two or more previously existing instances of a feature type are replaced by a single instance of the same feature type (19108).
- Feature Instance – a particular occurrence of a feature type.
- Feature Substitution – a form of feature succession in which one feature instance is replaced by another feature instance of the same or different feature type (19108). *Note: The example used in 19108 implies that a feature instance of one type is substituted for a second feature instance of a different type. Alternatively, one or more feature instances of the same type but with potentially different geometries could be substituted for a feature instance of the same type.*
- Feature Succession - replacement of one or more feature instances by other feature instances, such that the first feature instances cease to exist. *Note: Feature succession rules and procedures need to be defined in more detail, particularly as to how "replacement" is expressed.*
- Feature Type – a category of feature, as defined by a business.
- Geometric Object - a spatial object representing a geometric set. May be the spatial representation of an object such as a feature or a significant part of a feature (19107).
- Properties – the characteristics of a feature, encompassing both thematic and geometric descriptions.
- Versions – multiple representations of an instance of a feature, attribute, or geometric description. Each representation describes an alternate state at a different time or from a different source at the same time. The aggregate of versions describe

a feature's timeline, which could be a network if multiple concurrent representations are permitted. This concept is a specialized use of Feature Association. *Note: This definition was created for this document, and should be revisited by the Stage 0 Project.*

1.4 Organization of this document

This document is organized as follows.

- Section 2 discusses requirements for representing time-varying geospatial information that the current standards do and do not support sufficiently.
- Section 3 describes concepts and an approach for developing the necessary application schemata.
- Section 4 presents recommendations for proceeding with the work to develop standard application schemata.
- Section 5 describes existing standards and interests that affect or are affected by this work.

2 Addressing spatiotemporal requirements via standards

Standard schemata exist for spatial and temporal information (19107 and 19108, respectively). The schemata address the requirement to describe dimensional features via geometric objects, and to reference dimensional features to locations in time and space. The schemata in their current form do not specifically address requirements to describe change over time to dimensional features.

This section briefly describes requirements that are addressed by the existing standards, and those that are not adequately addressed by the existing spatial and temporal standards.

2.1 Requirements that are addressed by existing standards

The existing standards (19107 and 19108) are sufficient to describe some types of change over time. 19108 discusses "feature association" and "feature succession," which provide sufficient capability to meet the following requirements.

2.1.1 Schema change over time

The present standards are adequate to describe changes to a schema over time. The necessary schema elements exist to describe the following.

- A Feature Type is added or removed.
- A Feature Type's properties change, resulting in the removal of some Attribute Types and the addition of others.

2.1.2 Sequent measurements at a point

The present standards are adequate to describe a series of measurements taken at a single location. Examples of this case includes in situ sensors such as stream gauges or data buoys, and also plots that are sampled over time to measure change (e.g., for vegetation surveys). Section 8.3.2 of ISO/FDIS 19109:2003(E) includes an application schema for measurement activity in a single location at a defined frequency.

2.1.3 Changes that do not track feature ancestries

The present standards are adequate to describe changes that are represented by the birth (insertion) of new instances of features without reference to their ancestors, and the death (retirement) of existing instances of features without reference to their descendents. For example, a new data source could spur the update of a broad area of vegetation, soils, land use or land cover, demographic information, shoreline, etc. The feature succession construct from 19108 would be used to retire existing features by adding a timestamp to close their periods of validity. Then new features would be inserted with a period of validity open at one end. This approach is common in legacy systems. It is also useful for representing base data. The approach supports the query: "Show me the state at a given moment in time," but not "Show me how this feature changed over a specified period of time."

2.2 Requirements that <u>are</u> <u>not</u> adequately addressed by existing standards

The existing standards (19107 and 19108) are not sufficient to address a number of business needs that concern time-varying features. The inadequacy is not necessarily due to a lack of standard schema elements. The problem relates more to how open-ended the implementation options are, which makes interoperability among different developments extremely unlikely. For that reason, a set of standardized application schemata for specific usages is highly desirable. This section is a starting point for determining which application schemata could be standardized. A corresponding approach may be to provide an unambiguous set of rules for the definition of application schemata for time-varying information.

2.2.1 Moving features

The existing standards are not adequate to describe features that move in three dimensions (x,y,z). The simplest case is non-dimensional features (points) that move, or dimensional features that move without deformation, rotation, or change in dimension or thematic property. The more complex case is dimensional features that divide, fuse, rotate, and change in shape, dimension, and thematic property. In both cases, motion could be described via a function (e.g., velocity and direction, orbital ephemerides, behavioral model).

Features can move on constrained paths (e.g., on-road vehicles, trains, orbital objects) and on relatively unconstrained paths (e.g., aircraft, animals, foot traffic, off-road vehicles, named storms).

Manipulating moving points, lines, and areas requires operations to answer queries like "When does this moving point enter that (moving) area?", "What is the trajectory of the moving point inside the (moving) area?", or "What is the speed of this moving point?". Operations defined for fixed spatial types have to be extended to the moving spatial types in a standard way or systems will not be able to interoperate.

Moving features are a key business element of many markets. Location-based services are provided relative to a traceable moving feature, Intelligent Transportation Systems assume a set of traceable moving features, and modeling and simulation can operate on moving features. Thus, moving features are of interest to these groups: ISO TC211 WG8, ISO TC204, ISO JTC1 SC24 and ISO JTC1 SC32.

It is imperative that the core conceptual model for moving features be shared among all interested parties to ensure proper interfaces between market areas. It is also imperative that backward compatibility is achieved for existing implementations (e.g., that of SC24). Backward compatibility is also needed for spatial geometries defined by 19107 and temporal referencing defined by 19108.

This discussion paper recommends that an application schema for moving features be fast-tracked via a New Work Item (see Section 4). The rationale for fast-tracking moving features is that their issues and concepts are well understood, and as such will invite constructive discussion, development of terminology, and generation of a conceptual schema that is forward-compatible to other types of time-varying features.

2.2.2 Incremental change to the thematic properties of a feature instance

The present standards are inadequate for tracking a series of changes to a feature instance's thematic properties, e.g., a building whose horizontal accuracy, color, or usage changes; or a navigation aid whose light or sound change. The key issue concerns "versioning", which involves creating multiple representations via additional database records to describe versions of a feature instance. If a single property of a feature instance changes, the following options exist.

- Create a new version of the entire feature instance (geometry and thematic attributes).
- Create a new version of the thematic attributes only (which are referenced to the feature instance).
- Create a new version of only the attribute value that changed.

Arguments for and against each of these practices exist. A designer's choice is based on the capability of software used and the expectation of how feature types could change. The standard should provide an application schema that offers a choice to designers, while still ensuring clear communication and interoperability. The existing constructs of feature association and feature succession (19108) can be extended to offer a basis for addressing these requirements.

2.2.3 Incremental change to the geometric properties of a feature instance

The present standards are inadequate for tracking changes to a line or area feature's geometric properties, e.g., a road that over time is partially paved, one section is straightened, and a third section is closed (see example in Section 3). How to create versions is one issue (see the discussion in the previous section on versioning for thematic properties). This includes the case where the dimensionality of geometry changes, e.g., from line to area. A second issue is how to derive and reference fragments of geometry to represent the geometric change. Options include the following.

- The geometry for one version of a feature has topological intersections within that moment in time alone.
- The geometry for one version of a feature is intersected across an interval in time for that feature instance alone.
- The geometry of one version of a feature is intersected across an interval in time for all feature instances.
- Each vertex of the geometric representation is described via (x, y, z, t).

As with other considerations involving versioning, a designer's choice is based on the capability of software used and the expectation of how feature types could change. The standard should provide an application schema that offers a choice to designers, while still ensuring clear communication and interoperability.

2.2.4 Time-varying aspects of networks and categorical coverages

Time-varying aspects of networks and categorical coverages pose special challenges. Examples of these types of features include census tracts, administrative boundaries, road networks, hydrological networks, cadastres, managed vegetation (crops or plantation forests), open-cut mine shells, land cover classifications. There is enormous incentive and interest in reaching consensus on how to represent time-varying aspects such that proper analysis is possible.

The challenge lies in the fact that when one component of the network or coverage undergoes geometric change, the geometric description of other components may be affected. In addition, analysis may summarize differences between complete states, or it may analyze the history of one feature type or one feature instance. .

2.2.5 Complexity in timeline topology

It is possible to have a timeline topology that is a network, as described below.

- If a feature instance divides and fuses, the versions form a networked timeline topology. Examples include animal herds, refugee groups, segments of a highway, and parcels that are subdivided or amalgamated.
- If multiple sources of a feature instance are used to create multiple representations that co-exist in time, the concurrent versions form a networked timeline topology. Examples include forest stands delineated via multiple interpretations, shorelines

delineated using different tides and datums, and administrative boundaries that are disputed or whose legal descriptions do not provide clear ground locations.

This issue is discussed briefly in 19108, but its treatment needs expansion and clarification in the spatiotemporal context.

2.2.6 Explicit tracking of the history of spatial topology

Spatial topology sometimes is described explicitly in stored data. Thus, in addition to describing thematic and geometric properties, there are explicit references to the graph that provides underlying structure to the data (i.e., begin node, end node, left face, right face). If geospatial change is tracked, the question remains whether it is required to track changes to the explicit topological references (i.e., previous begin node, next begin node, etc.) There is no obvious requirement to track changes to spatial topology, but this must be confirmed through consultation.

2.2.7 Temporality of surfaces and solids

Surfaces and solids change over time, and standards are needed to describe these changes. Key business drivers will come from mining, petroleum, water resources, oceanography, and geophysical sciences. An example scenario would be the tracking of meso-scale and micro-scale current eddies in the Gulf of Alaska, as part of a global ocean circulation and climate model. Eddies can be modeled on the sea surface, with the added complexity that every point on the surface has a velocity and direction (i.e., is a 3D point vector). As time advances, the centroid of an eddy moves on a trajectory and the current moves around it, causing fluctuations in sea surface height. Eddies also can be modeled as 3D solids rather than as surfaces, which introduces new challenges. Similar requirements can be drawn from the field of petroleum reservoir engineering, where knowledge of the interface between gas, petroleum fluids, and ground water is paramount for the design of effective recovery mechanisms. It will be important to define key requirements and their appropriate spatiotemporal treatments to be backward-compatible with the 0D, 1D, and 2D treatments.

2.2.8 Explicit causal links

Businesses need to be able to express whether a feature type is a state, event, or evidence. These distinctions support the representation of causal relationships between time-varying features. States and events are defined in 19108, Section 5.5.2, as follows.

- An event is an action that occurs at an instant. In fact, almost every event occupies a short interval of time, but when that interval is short relative to the resolution of the scale of measurement, it is specified as an instant. The GF_AttributeType.valueType of an event shall be either a TM_Instant, a TM_Node, or a TM_TemporalPosition.
- A state is a condition – a characteristic of a feature or data set that persists for a period. That characteristic may be represented by a feature attribute or metadata element. A GF_TemporalAttributeType that describes a state may be instantiated in two ways. In the simple case, the GF_AttributeType shall be instantiated as an

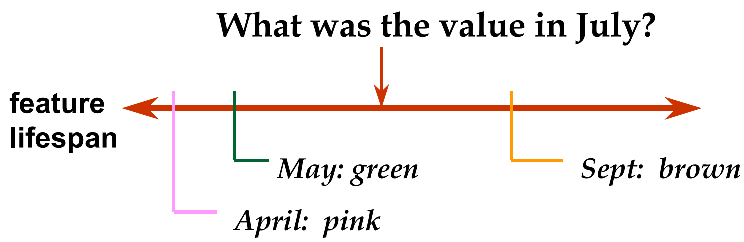
attribute of a class that represents a feature type. Its GF_AttributeType.valueType shall be either a TM_Period or a TM_Edge. When more information is needed, a GF_TemporalAttributeType that represents a state shall be instantiated as a UML class. That class shall be a subtype of TM_Period that inherits the associations Beginning and Ending, or a subtype of TM_Edge that inherits the associations Initiation and Termination. The characteristics of the state shall be described by one or more attributes of the class. Its recurrence shall be indicated by the multiplicity at the attribute end of its association with the feature type class. Often, a change in state is associated with an event that initiates or terminates the state. That event shall be identified by an attribute of the class that represents the state.

These definitions relate primarily to timeline geometry. The following working definitions are proposed for the business constructs. New terminology may be needed to separate the business and schematic concepts.

- Business description of a state: same as in 19108. A state has spatial and temporal extent, and associated thematic properties.
- Business description of an event: An occurrence of importance to the business, and which is capable of inducing state change. Examples include storm, insect infestation, wildfire, flood, battle. Business events are represented just as any other feature type, since they have spatial and temporal extent, and associated thematic properties. Business events can have sub-events that (e.g., stages of flooding, spot fires, specific campaigns within a battle).
- Business description of causal links: States and events are assumed to be independent, unless a causal link is detected. The possibility of causal linkages among states and events must be defined by the business, as in the examples below.
    - Event contributes to state change: windstorm causes blowdown of trees; flooding causes road washout.
    - State contributes to event properties: heavy brush contributes to spread of wildfire, single-species forests contribute to spread of insect infestation.
    - State contributes to state change: trees beside a clearcut are blown down while those in the forest are intact.
    - Event triggers subsequent event: electrical storm causes wildfire.
- Business description of evidence: the sources by which states, events, state change, and causal links are detected. Evidence has spatial and temporal extent, and associated thematic properties. For example, an air photo covers an area on the ground and was taken at a particular time. A ground survey may have plots (points), transects (lines), and have occurred over a particular period.

3 A framework for addressing the issues

This section describes a framework for spatiotemporality that revolves around the concept of tracing and analyzing the history of change over time to features, or "time-varying features."[1] The term "spatiotemporal" has broad and ambiguous meanings. Business requirements are considerably more specific, and revolve around a set of features defined by the business to be of key importance. Features may be of 0, 1, 2, or 3 spatial dimensions. Multiple states of a feature can appear along the timeline (see figure below), changing in constrained or unconstrained ways.



The next subsections discuss concepts of that will be of use to the work that will follow.

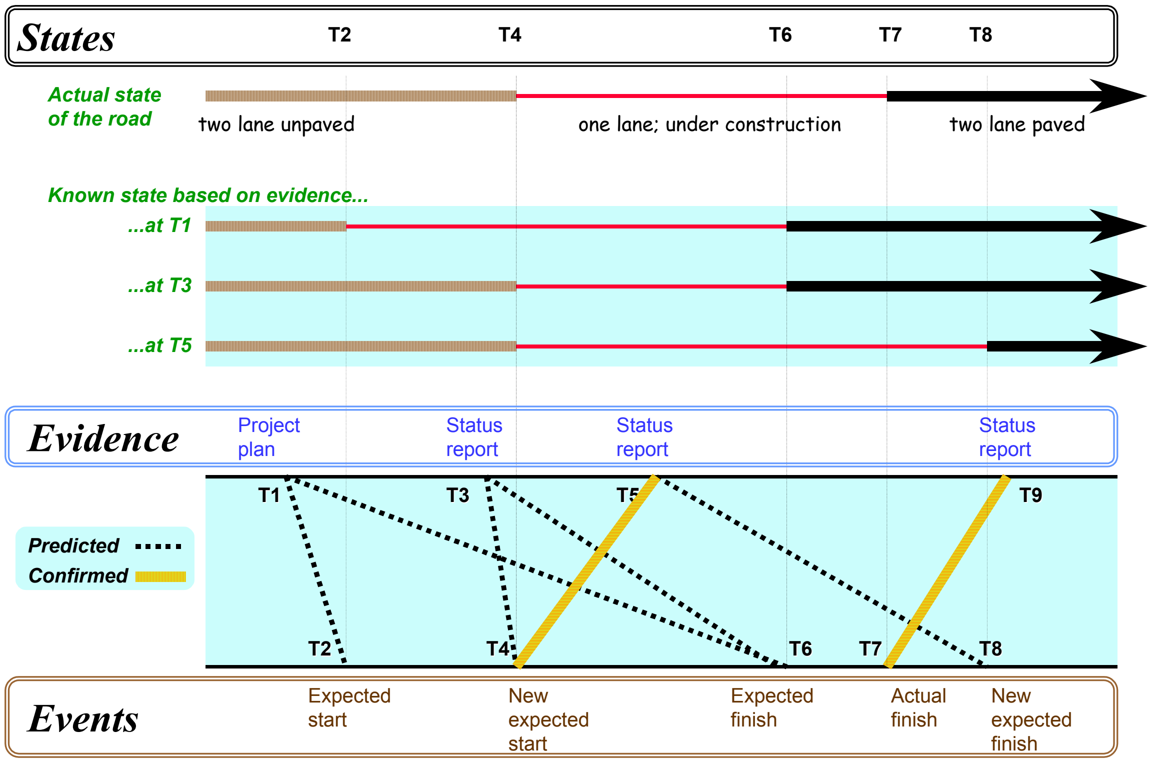
3.1 Case study of time-varying information management

Real-world business systems have data with quality problems. Changes to the data come about through processes that may be poorly understood, subject to change, or otherwise unpredictable. Information about the changes can be out of sequence or in error. A business may need to know more than what changed; it may also need to know what was planned, intermediate steps, and what was represented by the system (and thus known to the enterprise) at each point in between. The example below shows how a highway department might track a road-paving project that proceeded as follows.

- Plans are made to pave a stretch of highway.
- The schedule changes several times.
- Parts of the road are closed, and detours are added.
- Finally construction is completed.

In this simple example, the highway department needs to track information about the road (states), the actions taken to maintain the road (events), and the documents used to gain knowledge about the states and events (evidence). Note that the knowledge of a past moment at that same past moment can differ from what is known at a later date, when additional information about the past becomes available. Similar examples can be drawn from business systems that manage cadastres and land interests, facilities, utilities, forestry, agriculture, navigational charting, monetary transactions, and others.

[1] The same methods pertain to tracing a forecasted future of features.



3.2 Histories of feature instances whose identities persist despite changes

There is a business need to know specifics of feature changes. This makes it possible to analyze patterns and particulars of change over time. If a business views an element of business information as essentially the same thing despite its changes, then its feature type must support multiple representations (or versions) of a feature instance. The goal is to support such queries as follows.

- How has this building changed over time? When did its color change, and when was the last time it was purple? What is the average number of years between color changes, and is the most recent color change an unexpected deviation from pattern?
- When and how has erosion or accretion changed a parcel's boundary and size? Is there a trend in where the spatial change is occurring?
- When and where was the road re-routed? What were the effects of road re-routing on business that once were, or that now are, alongside the highway?
- How have changes to the bus schedule affected the use of the bus stop nearest the mall?

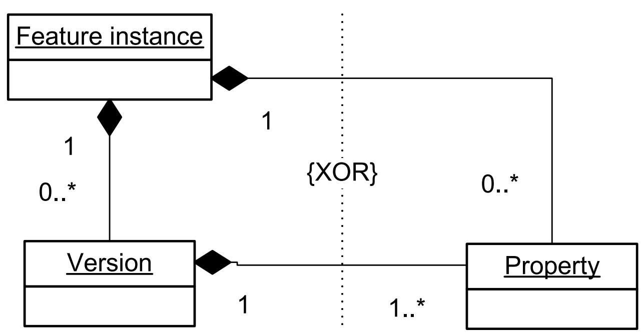
As illustrated above, businesses may need to analyze information concerning what specific aspects of a feature instance's thematic or spatial properties changed.

The concepts of association and succession as described in 19108 provide a basis for these constructs. Business rules are required to define whether only one representation can be valid for a given moment in time (as for a temporal feature that does not divide or fuse), or whether multiple representations are permitted (as in multi-source, multi-resolution, unconflated, or uncertain systems). It cannot be assumed that a query for successive versions will produce correct results without explicit linkages and rules (e.g., using TM_Order.relativePosition together with one or more of the Spatial operators defined in 19107).

The conceptual model below illustrates the situation. A feature instance has one or more versions. Each version has properties associated with it (which may change independently). The feature instance itself may have properties that are defined by the business as integral to the feature type, such that the value is constant for each version of a feature instance. If the value of an integral attribute changed, business rules cause that feature instance to "die" and be reborn as something different. For example:

- A public green space can be enlarged, replanted, and its hours of use can be changed, while still remaining a public green space. However, if it is paved or sold into private hands, it is considered to have died and become a new feature.
- A lighthouse can be painted, rebuilt in place, and its light characteristics can be altered slightly while still remaining the same lighthouse. However, if it is moved more than a certain distance or if its light is removed, it is considered to have died and become a new feature (i.e., a new lighthouse or not a lighthouse, respectively).

The concepts of "substitution" and "instantiated associations," as described in 19108, 5.5.4.2.2, are useful.[2] However, the methods and terminology need to be extended somewhat, and their usage needs to be standardized.



[2] Temporal feature associations of the feature succession type may also be instantiated in an application schema as UML associations between feature type classes, or as self-referent associations of a generic feature class. The names, roles, and multiplicities shall be different for each type of succession. The role names shall indicate the order in which one feature succeeded another. To include the time at which succession occurred, an application schema shall represent the succession association as a UML association class with an attribute that identifies the time of occurrence.

3.3 Multiple representations of feature instances

Pluralistic representation of features (i.e., multiple representations of feature instances) can result from storing multiple geometries of different scale or detail, from storing information from multiple unconflated data sources, and from multi-temporal representation. The methods used to model all these variants of multiple representation should be the same.

3.4 Orthogonality in the information model

If "when/where" semantics are expressed as orthogonal to "what", there is economy of expression. This is also a more natural representation of time-varying information, which leads to quicker comprehension and adoption. The illustration below is based on work by the Advanced Database Research Group[3].

When/ Where?

What?	**Temporal** (e.g., valid, transaction, temporal granularity and indeterminacy)	**Spatial** (e.g., shape, dimension, spatial granularity and indeterminacy)	**Time-varying spatial** (e.g., change in position and/or shape)
Entity Class • Simple • Subclass • Composite • Grouping • Weak			
Relationship			
Attribute • Simple • Composite • Multi-valued			

By extension, if "where" semantics are expressed as orthogonal to "when", greater clarity and flexibility ensue. Orthogonality and thereby independence ensure that information is not locked into a structure that is too restrictive to permit it to grow and change with the application's requirements. For example, a system which today deals with moving features as dimensionless points may change to include the higher level geometry in 2 or 3 dimensions at a later time (e.g., the vehicle is represented with roll, pitch, yaw). If the temporal and geometric properties are orthogonal, it is easier to deal with the issue of multiple representation of geometry. A discussion from the MurMur project follows.

> Not every temporal model supports the association of time with objects, relationships, and attributes. In their support of temporal and spatial features most models supporting inheritance ignore the facilities offered by refinement and redefinition, thus illustrating

[3] University of Arizona (Sudha Ram, Richard T. Snodgrass, Vijay Khatri and Yousub Hwang)

> another way of not achieving orthogonality. They also often include unnecessary constraints on temporal specifications, like the validity period of an attribute…must be within the lifecycle of the objects it belongs to…This prohibits any reference from an object to another older object/value…For instance in a genealogy database, a Person object should be allowed to refer to its Person ancestors even if they did not live at the same time…These temporal constraints should be optional, depending upon the application.[4]

3.5 Maintaining forward and backward compatibility

Backward compatibility requires that the syntax and semantics of existing conceptual models remain unaltered. The objective of backward compatibility is to be able to develop schemata for time-varying information without invalidating extant legacy schemata for spatial and temporal, thus protecting the investments in existing standards and products. It also implies that both the legacy schemata and the new time varying information schemata can co-exist. If the extensions for advanced support for time-varying information is a strict superset provided by adding non-mandatory semantics, it would ensure that the extension is backward compatible with existing conceptual models.

Forward compatibility means that any approach to be considered must be extensible to address future requirements. While all future requirements cannot be foreseen, it still is possible to err on the side of flexibility when choosing a conceptual model. This means that new business cases should be able to be addressed using existing constructs in new application schemas. It also means that it is possible to introduce innovative technical approaches that still conform to the standards.

4 Recommendations

A comprehensive standard that will address all the issues related to time-varying information will take years to develop, discuss, and approve. But certain business cases and the methods needed to treat them are candidates for fast-tracking. Consequently, it is recommended that ISO TC211 undertake the following.

- Initiate a New Work Item to address the time-varying aspects of moving features.
- Initiate a Stage O Project to determine the best incremental approach for completing the standardization process for time varying information.

4.1 Initiate a New Work Item to fast-track a schema for moving features

The requirement for a standard schema for moving features should be addressed as part of a NWI (proposal attached). The work would be coordinated with location-based services, tracking and services, and multimodal LBS. It is recommended that TC211

[4] From MurMur Project – Multi-Representations, Multi-Resolutions, Workpackage 2 – The MurMur data modelling approach, Deliverable 4 – State of the Art review. Ref. project: UNIL/CP/MM-WP2-DLA-004/V4.0/ dated September 18-2000, page 21.

address the NWI for moving features with its own working group to ensure generality in the treatment of all moving features, including those not addressed by the three business communities.

The goal of the NWI will be to produce a conceptual schema for features that move in three dimensions (x,y,z) without deformation or change in dimension. The work would address the representation of features that move on constrained paths (e.g., orbital objects, on-road vehicles, trains) and on relatively unconstrained paths (e.g., aircraft, animals, foot traffic, off-road vehicles).

This proposed work item is separated from work on other types of geospatial change, which could be conducted as a parallel Stage 0 Project. The rationale for fast-tracking moving features is that their issues and concepts are well understood, and as such will invite constructive discussion, development of terminology, and generation of a conceptual schema that is forward-compatible to other types of geospatial change.

It is imperative that the core conceptual model for moving features be shared among all interested parties to ensure proper interfaces between market areas. It is also imperative that backward compatibility is achieved for existing implementations (e.g., that of SC24). Backward compatibility is also needed for spatial geometries defined by ISO 19107 Geographic information – Spatial schema and ISO 19108 Geographic information – Temporal schema. Standards and documents that may relate to moving features and require backward compatibility are 19107, 19108, 19109, 19132, 19133, 19134, 19136.

4.2 Initiate a Stage O Project for time-varying information

A Stage 0 Project should be initiated to address the following topics.

4.2.1 Identify parts of existing schemata that should be incorporated or revised

Candidates for incorporation or revision include dynamic features in GML (19136) and feature succession constructs (19108).

4.2.2 Identify application schemata that are ripe for spin-off and fast-tracking

The basis for choosing schemata to spin-off and fast-track includes these factors.

- Business cases must be generally well understood.
- There must broad informal agreement as to the appropriate technical approach.
- The technical approach should not be difficult to implement.
- There should be widespread need and a large potential market, which creates a strong incentive for investing the necessary effort to address the need.

4.2.3 Define use cases to document business needs

The lack of use cases is a deterrent to clear communication among discussants. Use cases are critical for defining common technical approaches that can be standardized in application schemata.

4.2.4 Analyze and document commonalities in requirements and approaches

The goal is to define a general and common means of treating time-varying information such that all businesses can communicate using the same core constructs, leading to widespread interoperability.

5 Standards potentially impacted

Many completed and ongoing efforts share common ground with the work described in this documented, as discussed below.

5.1 ISO TC 211

The following ISO TC211 standards have spatiotemporal components, and thus are potentially impacted.

- 19107- Spatial Schema
- 19108 – Temporal Schema
- 19123 – Schema for Coverage Geometry and Functions
- 19125 - Simple Feature Access
- 19130 - Sensor and data model for imagery and gridded data
- 19132 - Location based services - Framework
- 19133 - Location based services tracking and navigation
- 19134 - Location based services for multimodal routing and navigation
- 19136 – GML
- 19137 - Core profile of the spatial schema – Image and gridded

5.2 TC 204- GDF

ISO TC 204 includes capability to describe transit schedules and periods of validity, which are important to proprietary databases for traffic and routing applications. GDF includes a construct entitled "Restrictive Sub Attributes", which are (essentially) attributes that describe other attributes. The sub attribute called "validity period" can be used to describe the following situations.

- The gate is closed at certain periods of time except for emergency vehicles.
- The direction of traffic flow for the centre lane is east/west on Mon-Fri between 7-9AM and 4-6PM, west/east for all other hours, and restricted for use to only cars and emergency vehicles on Saturdays and Sundays between October 15-April 15.

5.3 JTC1 SC24 WG 8 – SEDRIS

Modeling and simulation are nearly synonymous to time-varying information. The methods used by SEDRIS for representing time-varying geospatial information must be evaluated and harmonization approaches defined.

5.4 JTC1 SC32 WG 4 SQL/MM Part 3 and OGC SFSQL

Significant work has been done in the area of adding standard temporal operators and datatypes to databases. The original SQL/MM Part 3 Spatial working draft included temporal elements. Migration of this work in JTC1 SC32 WG 3 resulted in a Part 7 Temporal. Due to a lack of interest from vendors and the inability to reach agreement on early progression, this work was deprecated. With an increase in technical capability the past interest has been renewed and it will be important to establish a liaison to ensure harmonization of effort.