Object = vector GIS

Object, element, feature class dimension/property/dimension entities

Category of dimensions (dimensions=properties) of entity values (objects):

1. spatial dimension
2. topological dimension
3. attribute dimension
4. graphic dimension – presentation of spatial objects
5. time dimension
6. textual numeric dimension

Object, element, feature class
1. spatial dimension

Spatial objects

= located in the space = contained = (embedding spaces)

A space is usually thought ne of the following spaces:

- 2D (= 2-dimensional) does not contain height information
- 2.5D height is given as descriptive (attribute) data
- 3D 3 dimensions
- 4D time is the 4th dimension

- For more, see geodesy – coordinate systems

Object , element, feature class
1 . spatial dimension

Geometric dimension of patial objects in GIS

- **dimensionless** - 0D – points
- **one dimensional** - 1D – line objects
- **two dimensional** - 2D – planar objects of finite size
- **three dimensional** - 3D – solids of finite volume with finite surface area (polyhedrons)

Object , element, feature class

1. spatial dimension

Your choice

real object

model

You have 2 options for choosing which geometric type to choose in GIS:

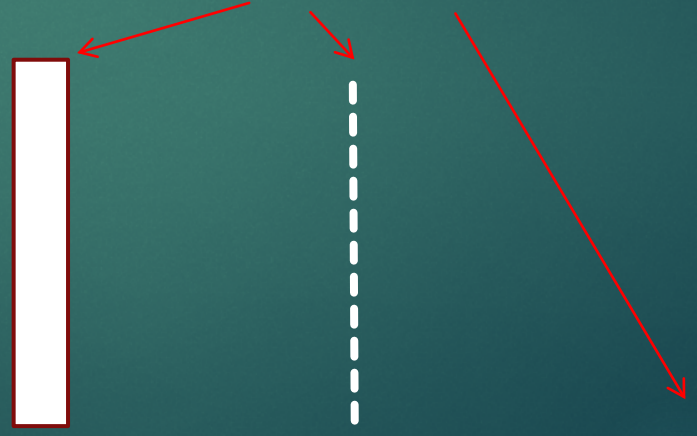
- **1) point object** = the **symbol for the building is used**
- **2) surface object** = is displayed as a **polygon**

Object , element, feature class
1. **spatial dimension**

Your choice

Real object

A possible **model**
3 options:



area object **line** object **point object** = symbol

Object, element, feature class
2. Topological dimension

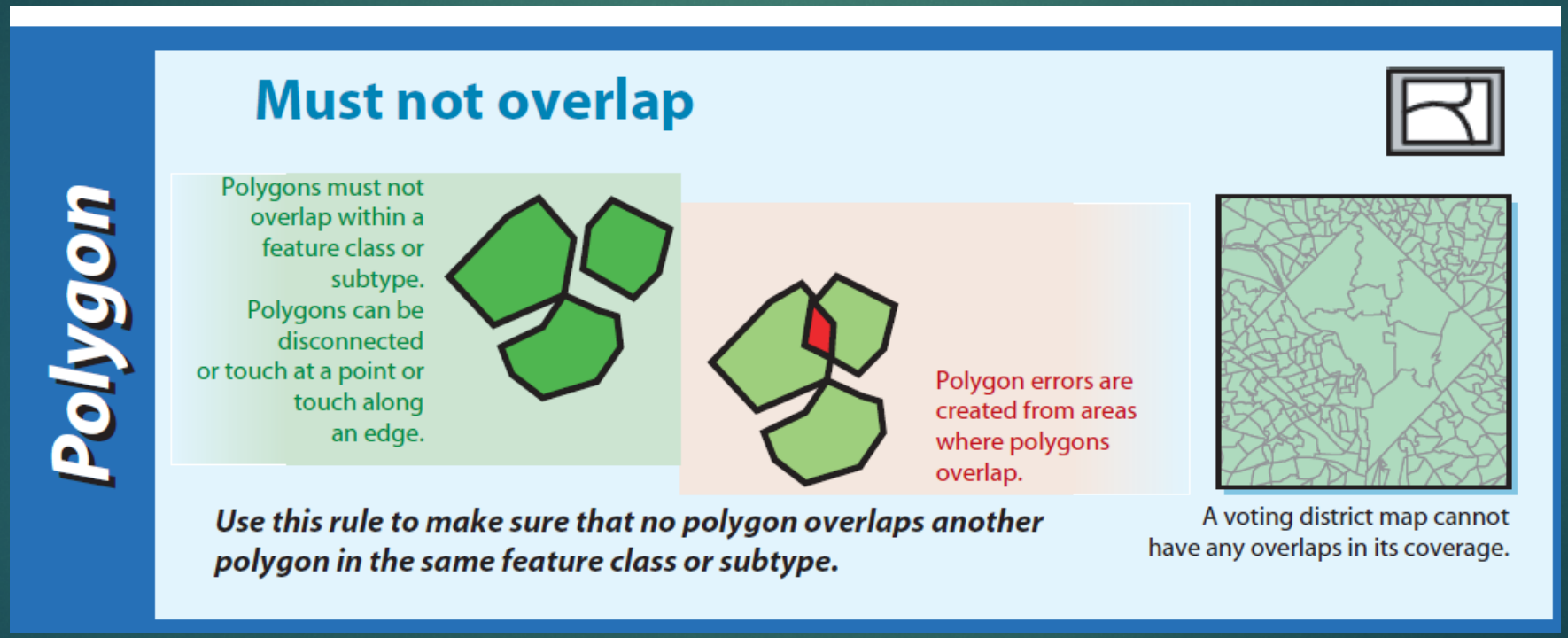
Topological dimension of a spatial object:

- **0. Vertex** – the point forming the shape of the edge = the shape of the object
- **1. Node** – the end/beginning of the object
- **2. Edge** – connector of 2 nodes
- **3. Line string** – more edges
- **4. Polygon** – area formed by a closed line string

Object, element, feature class

2. Topological dimension – topology check

Polygons of the same class must not overlap (parcel boundaries)



Object, element, feature class

2. Topological dimension – topology check

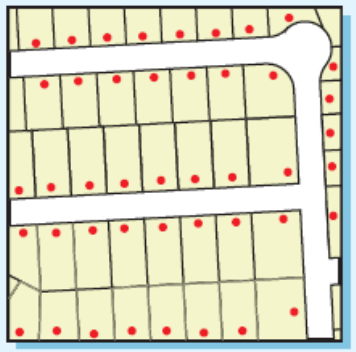
Polygons – each must contain one point (parcel and its number)

Polygon

Contains point

Each polygon of the first feature class or subtype must contain within its boundaries at least one point of the second feature class or subtype.

Polygon errors are created from the polygons that do not contain at least one point. A point on the boundary of a polygon is not contained in that polygon.



Parcels must contain at least one address point.

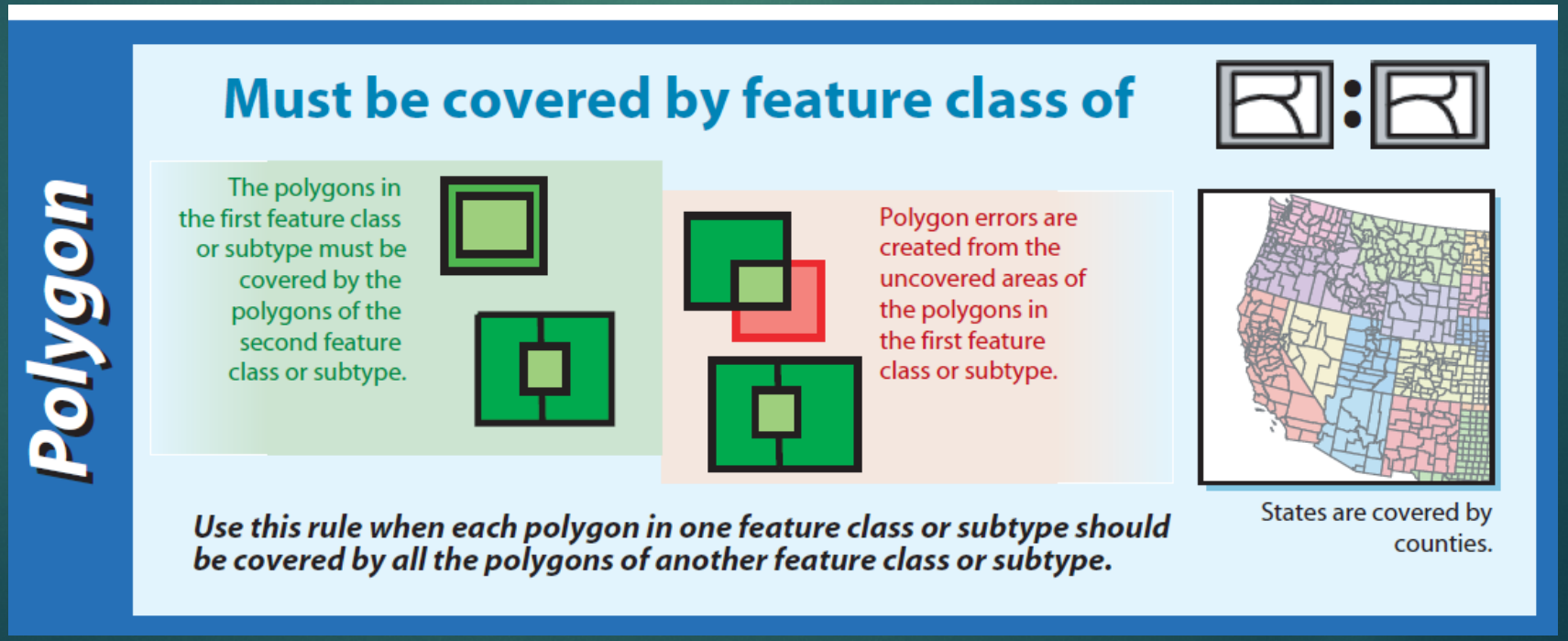
Use this rule to make sure that all polygons have at least one point within their boundaries. Overlapping polygons can share a point in that overlapping area.

Object, element, feature class

2. Topological dimension – topology check

Polygons

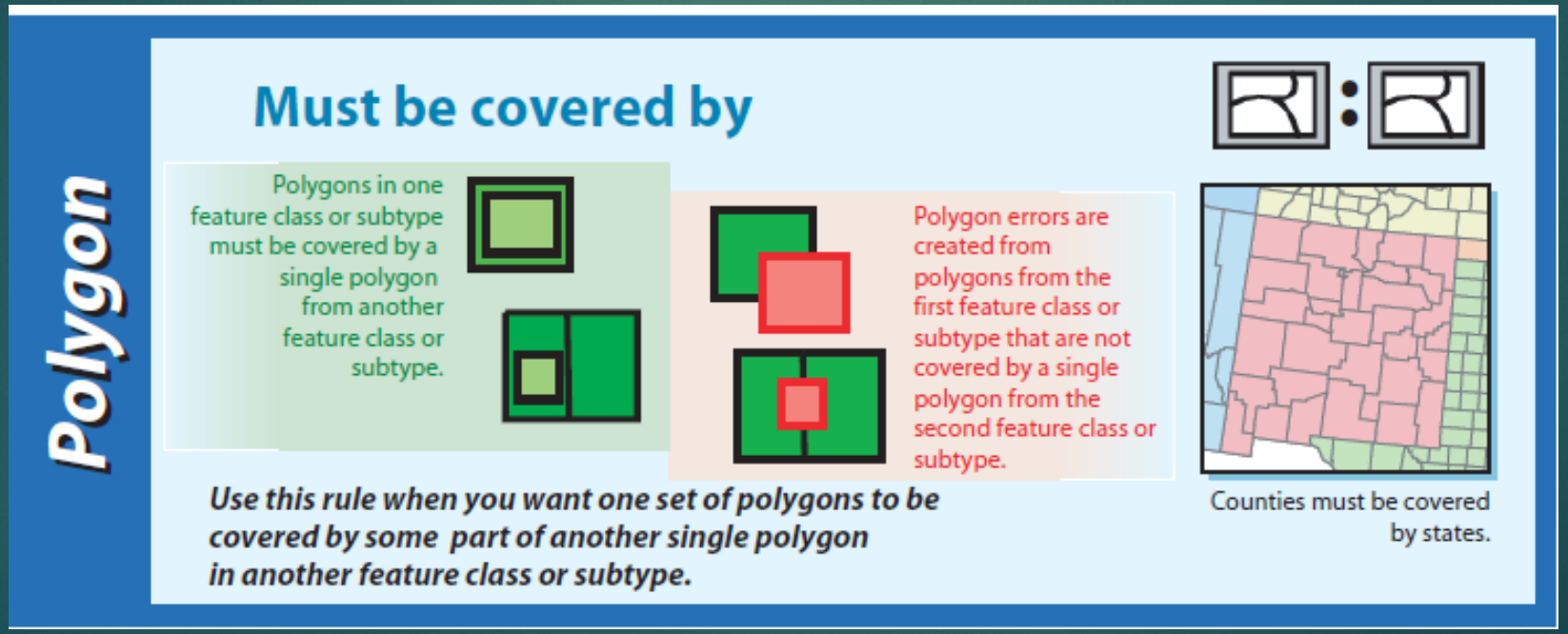
Each polygon of one class must be covered by polygons of the other class (districts are parts of regions)



Object, element, feature class

2. Topological dimension – topology check

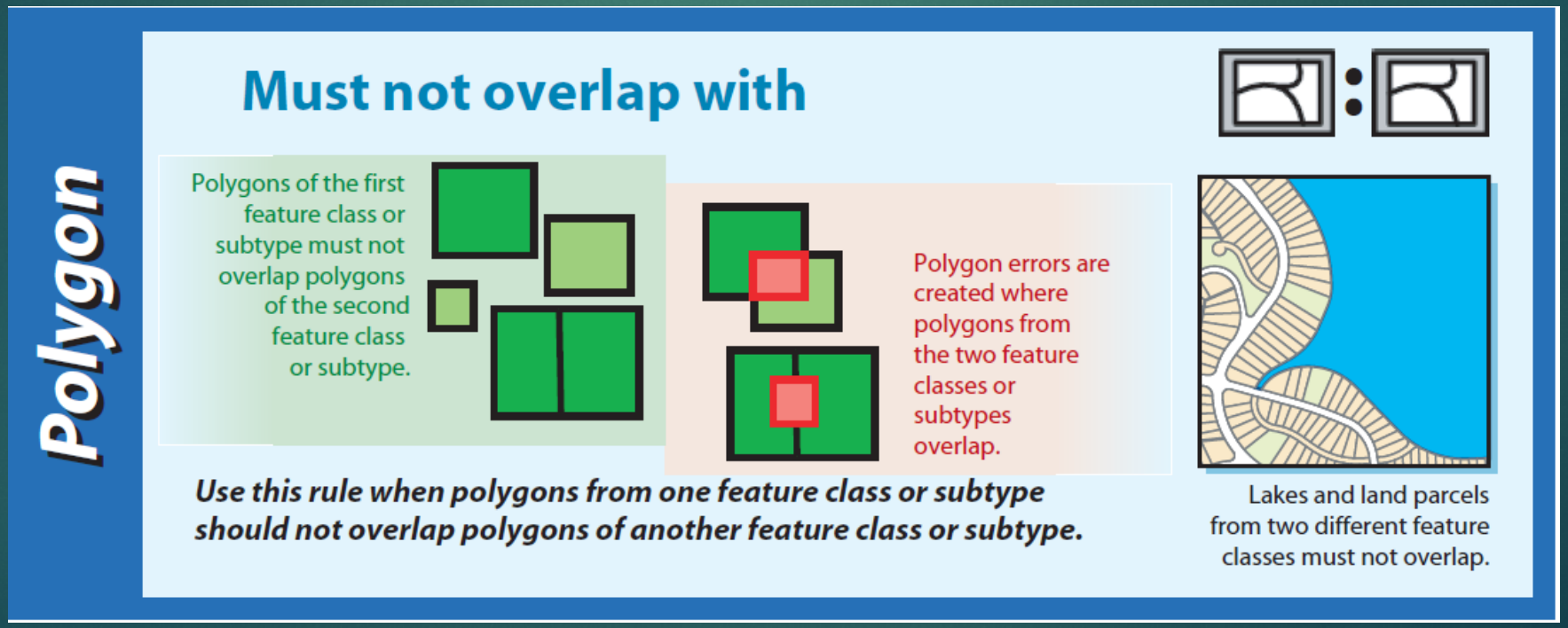
Polygons – polygons of one class must be covered by a part of one polygon of another class



Object, element, feature class

2. Topological dimension – topology check

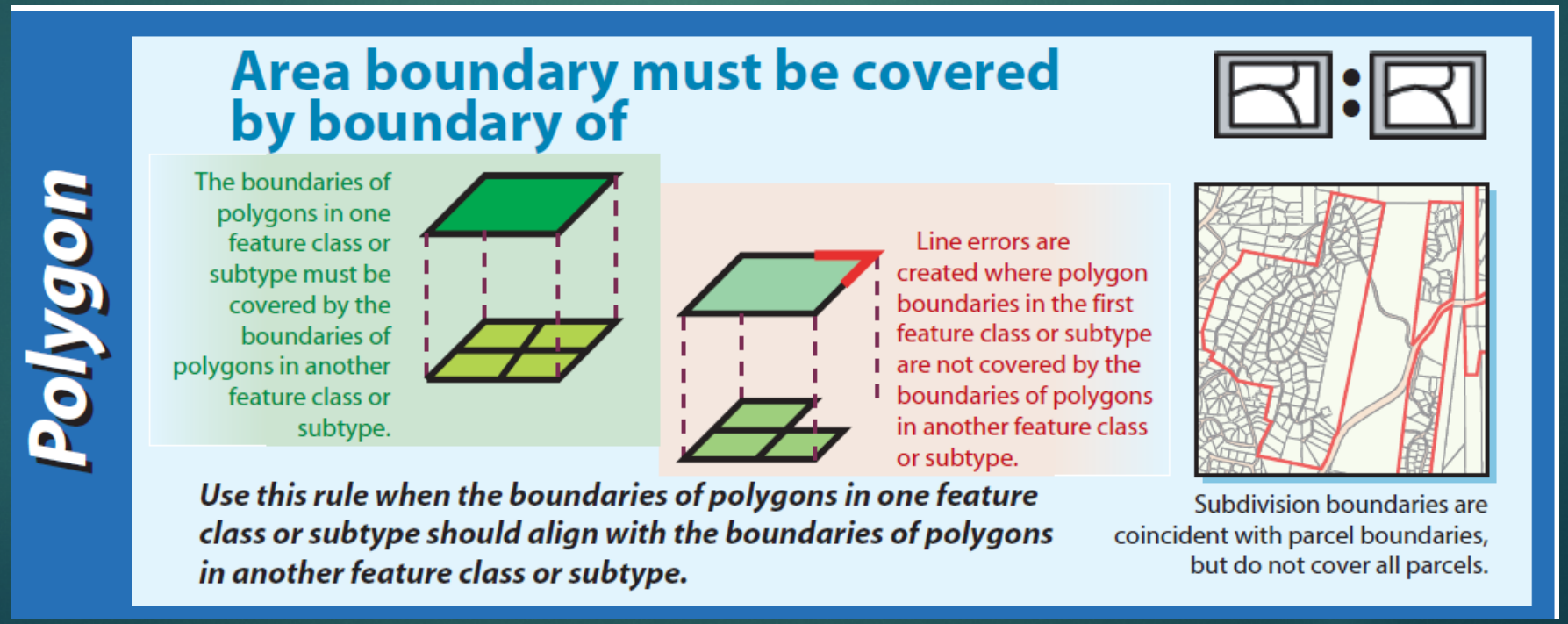
Polygons – of one class must not be covered by polygons of another class



Object, element, feature class

2. Topological dimension – topology check

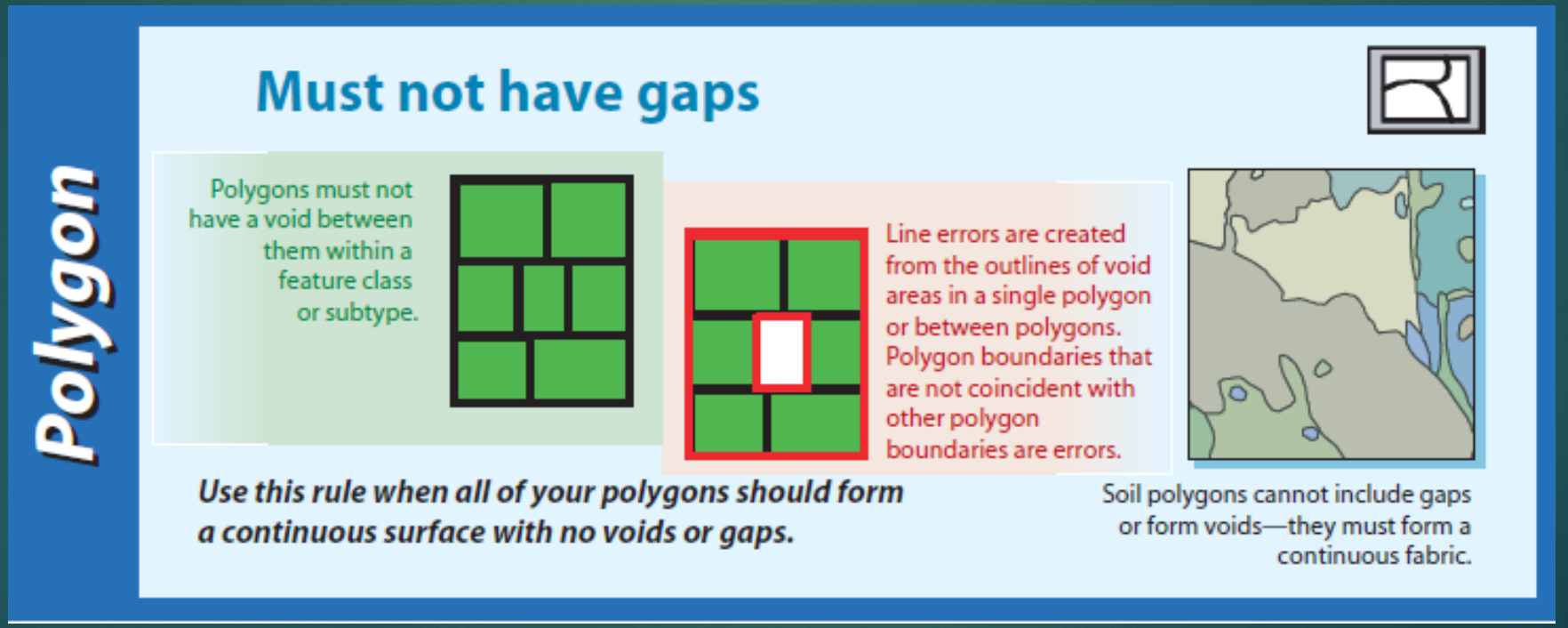
Polygons – the boundaries of polygons of one class must be covered by the boundary of the other class
(regions are divided into districts)



Object, element, feature class

2. Topological dimension – topology check

Polygons – the area of the territory must not contain holes



Object, element, feature class

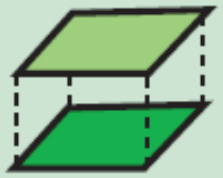
2. Topological dimension – topology check

Polygons of one class must be identical to polygons of another class

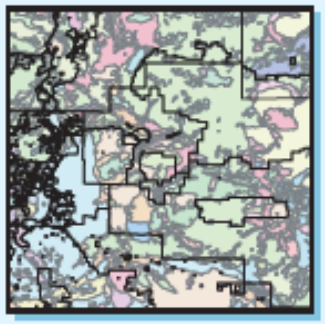
Polygon

Must cover each other

All polygons in the first feature class and all polygons in the second feature class must cover each other.
- FC1 Must be covered by feature class of FC2.
- FC2 Must be covered by feature class of FC1.



Polygon errors are created where any part of a polygon is not covered by one or more polygons in the other feature class or subtype.



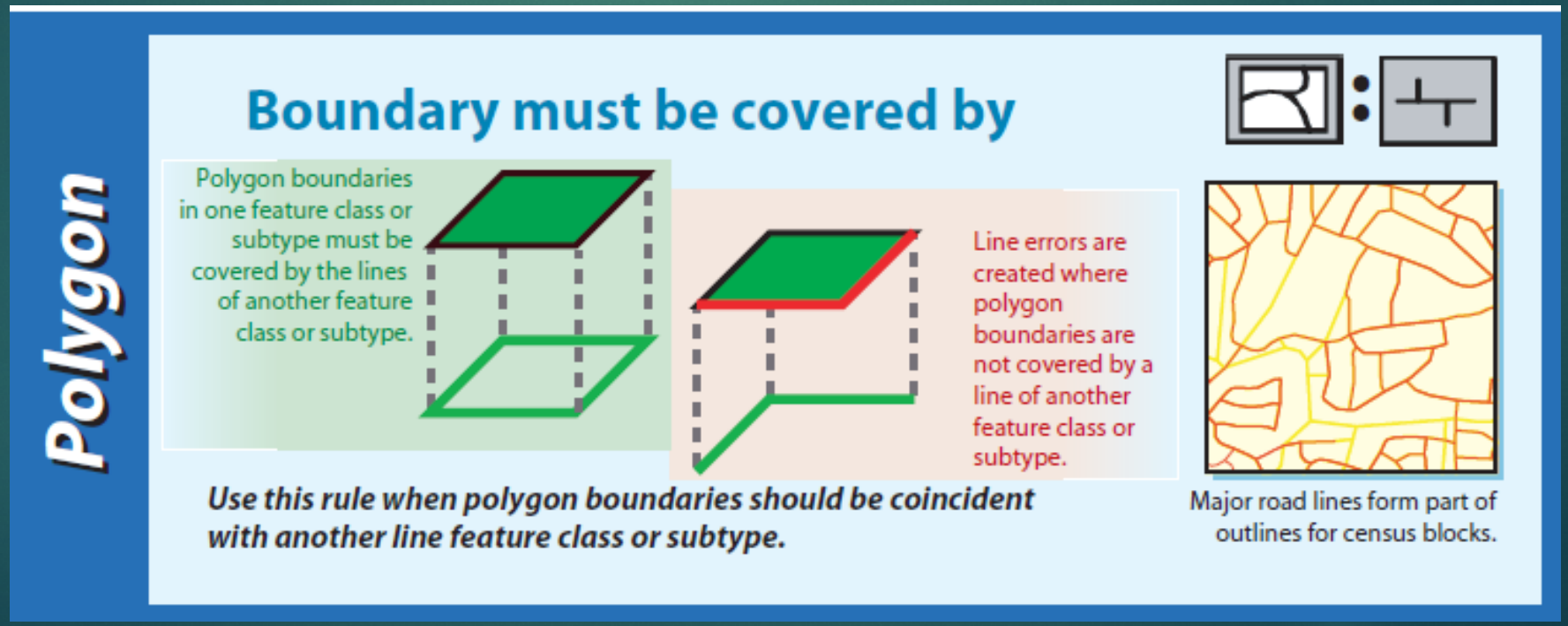
Vegetation and soils must cover each other.

Use this rule when you want the polygons from two feature classes or subtypes to cover the same area.

Object, element, feature class

2. Topological dimension – topology check

Polygons × polygon boundaries – polygons of one class must be covered by another line class (parcels and their boundaries)

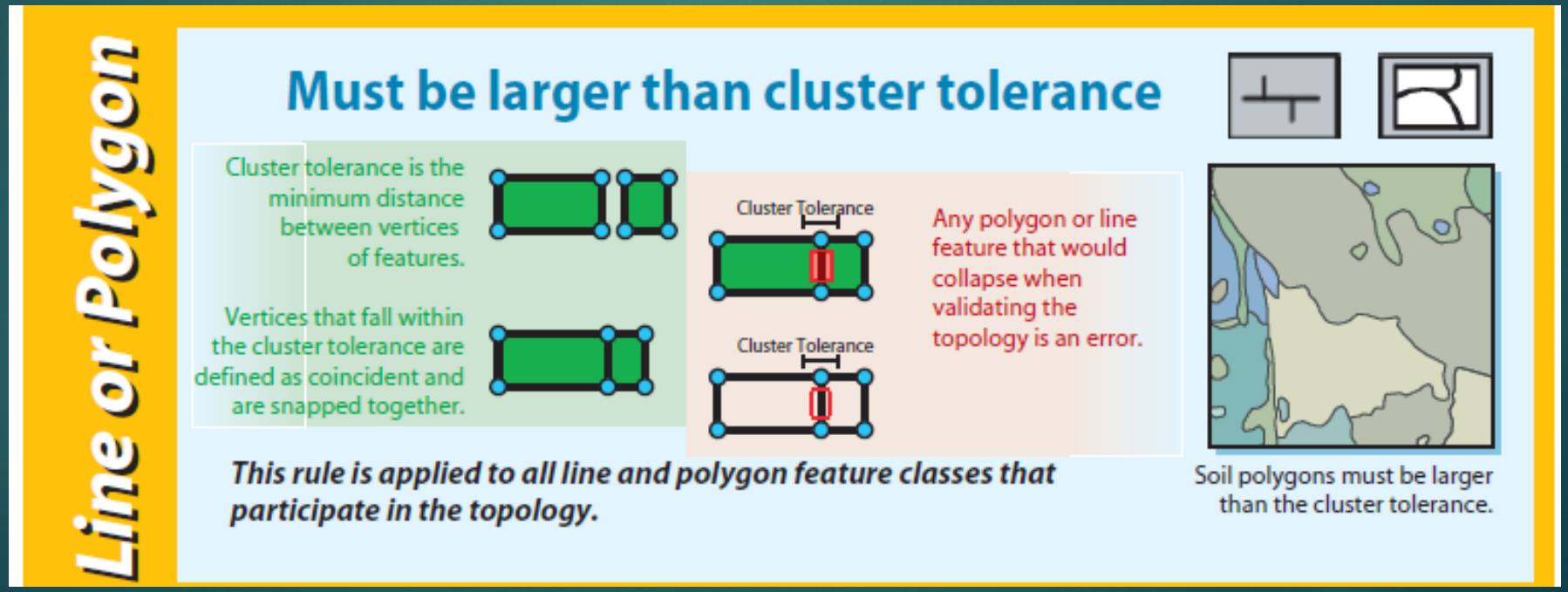


Object, element, feature class

2. Topological dimension - topology check

Polygons × boundaries between them

– if neighboring boundaries are within tolerance of each other, they will coincide during topology cleaning – distance threshold must be set



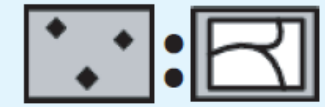
Object, element, feature class

2. Topological dimension – topology check

Polygons × points – all points must lie completely inside polygons (capitals lie inside states)

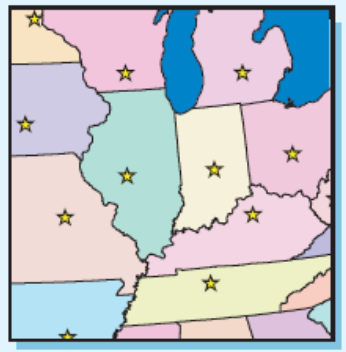
Point

Must be properly inside polygons



Points in one feature class or subtype must be inside polygons of another feature class or subtype.

Point errors are created where the points are outside or touch the boundary of the polygons.



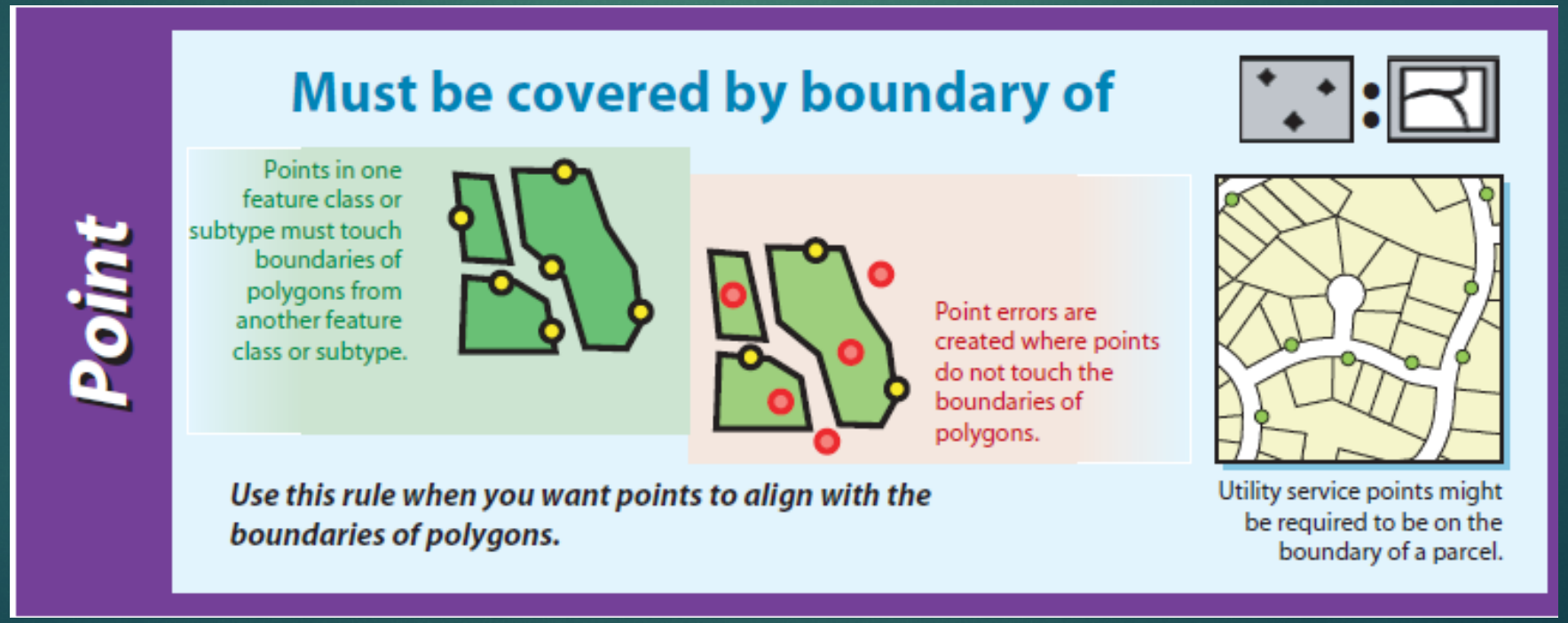
State capitals must be inside each state.

Use this rule when you want points to be completely within the boundaries of polygons.

Object, element, feature class

2. Topological dimension – topology check

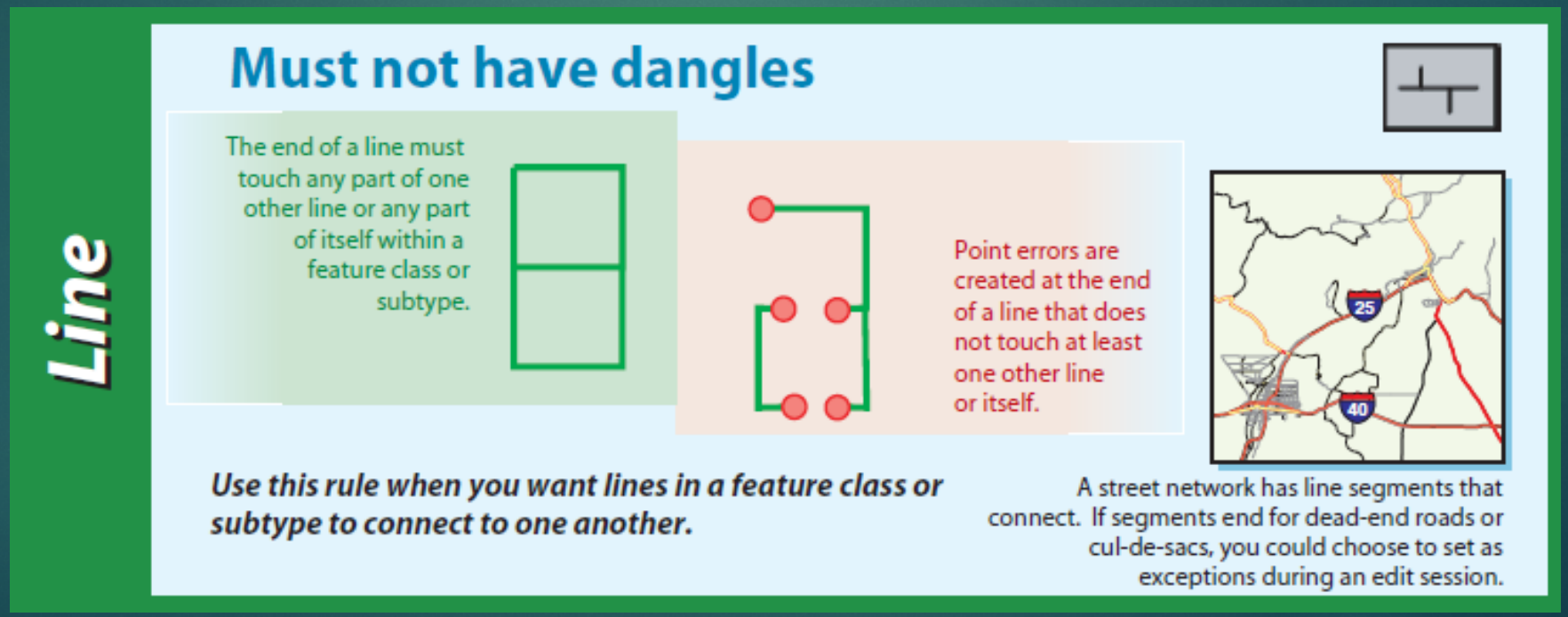
Polygons × points – all points of one class lie on the border of polygons (all border crossings lie on the border of states)



Object, element, feature class

2. Topological dimension – topology check

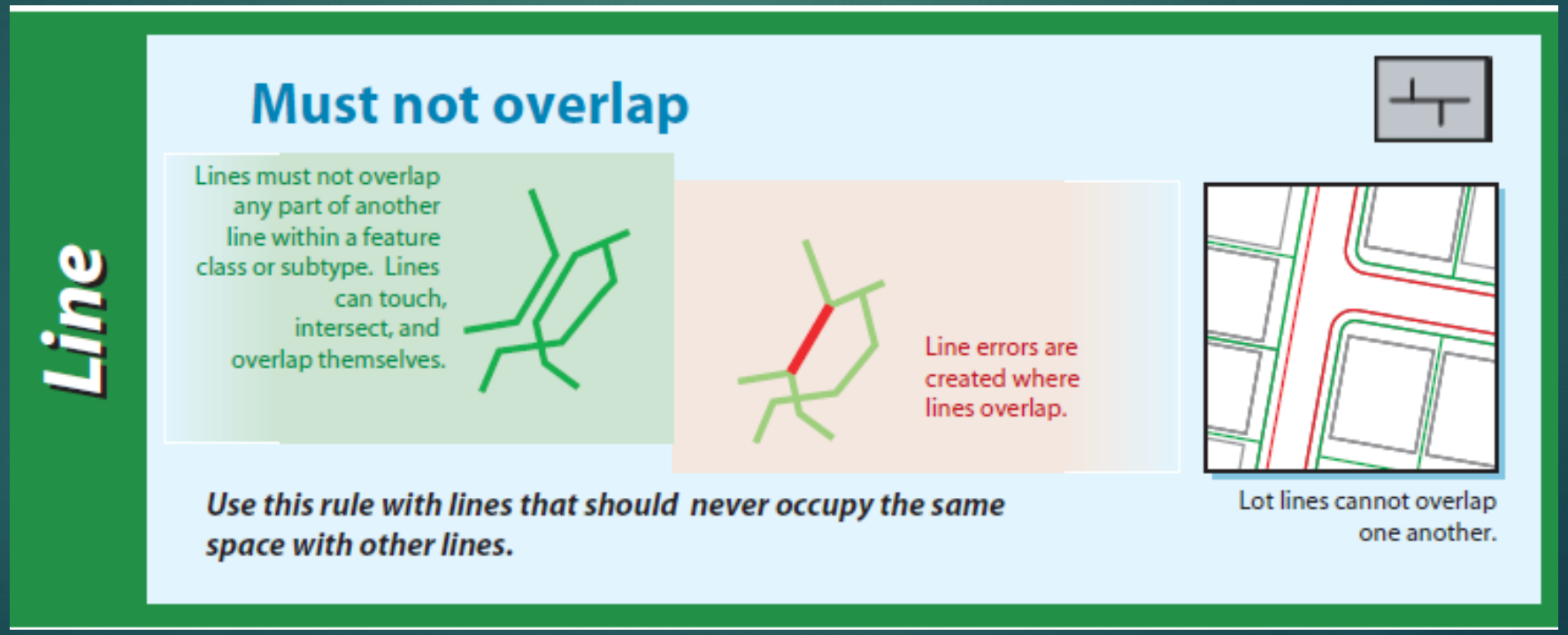
Lines must not have free ends (parcel boundaries must be closed to form area boundaries)



Object, element, feature class

2. Topological dimension – topology check

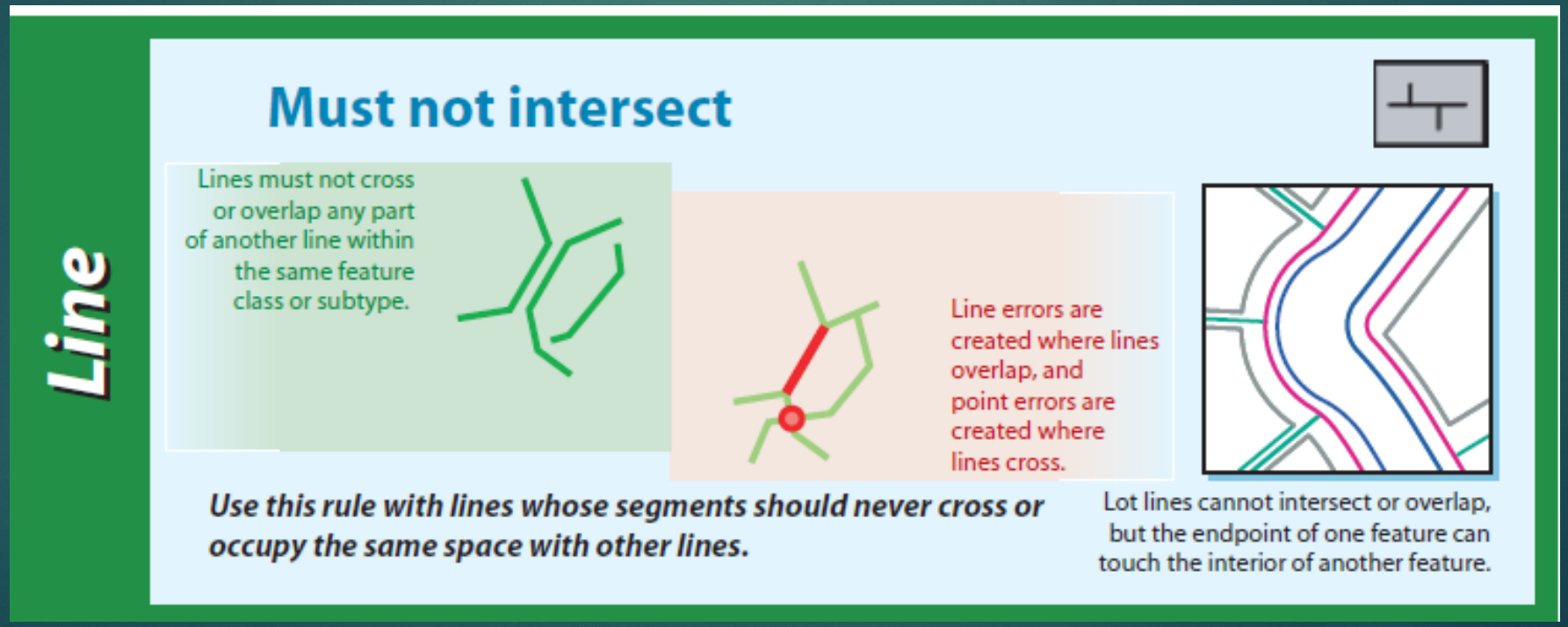
Lines of one class must not have the same position as another line of the same class, but they can cross and touch



Object, element, feature class

2. Topological dimension – topology check

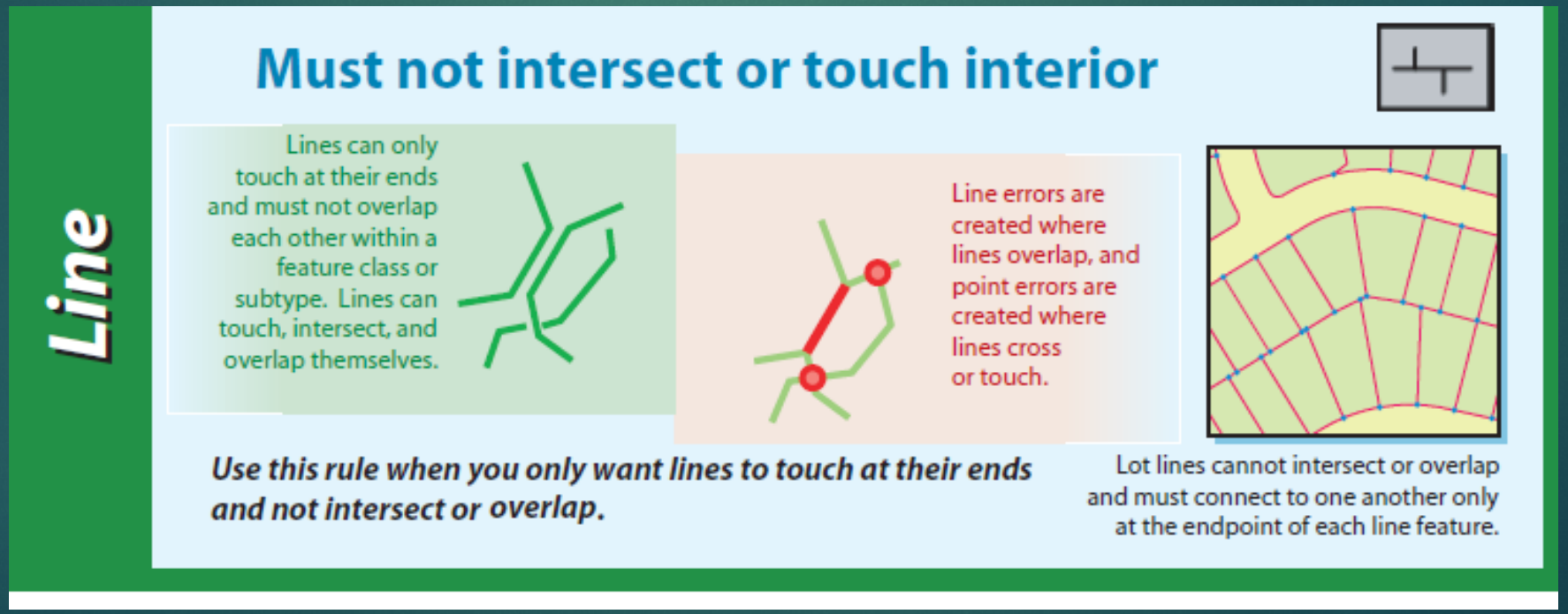
Line of the same class may not have the same position as another line of the same class, nor cross it, but may touch it



Object, element, feature class

2. Topological dimension – topology check

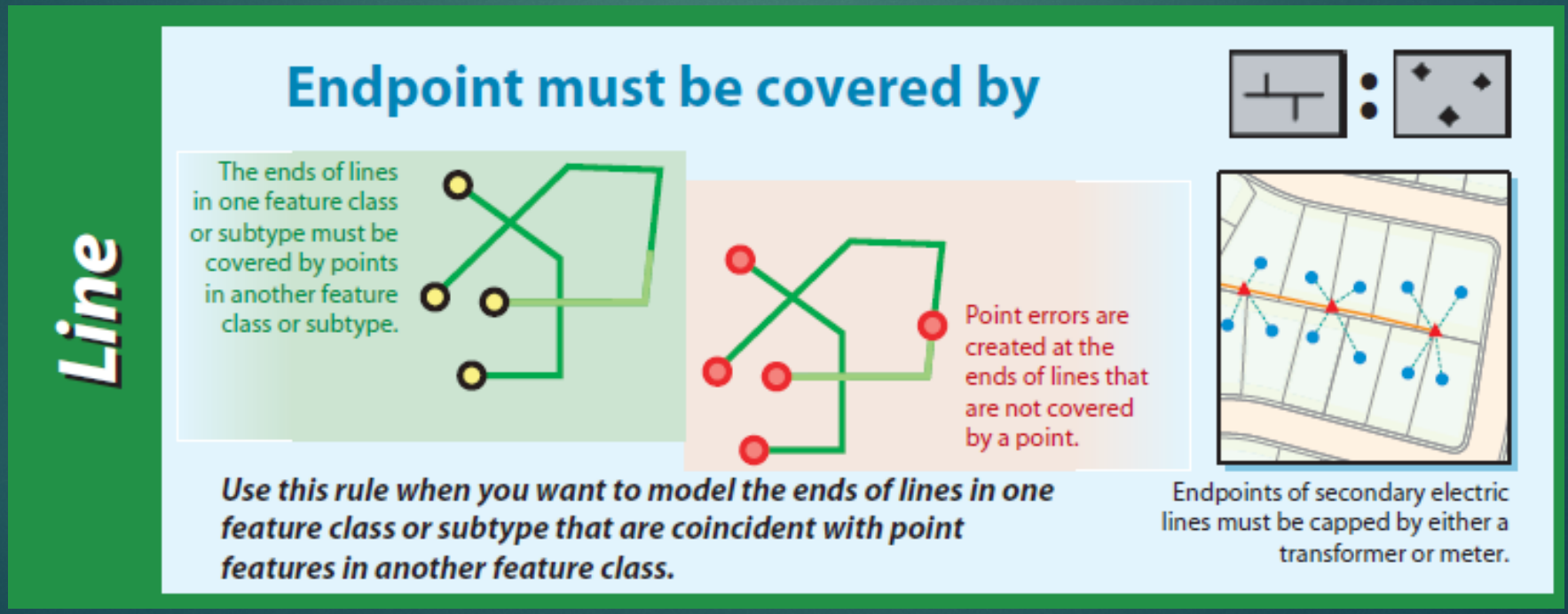
Lines can touch at the end nodes of the line, but not cross or overlap



Object, element, feature class

2. Topological dimension – topology check

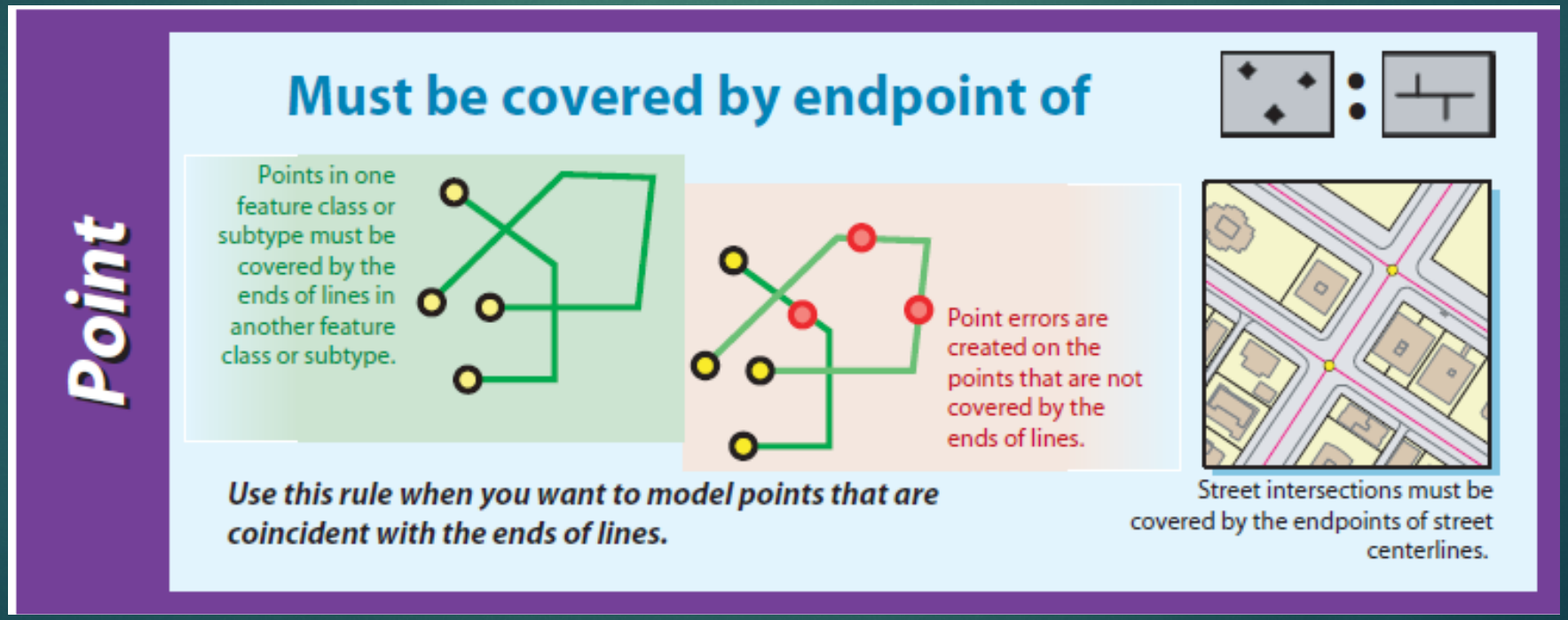
Line – point objects must always lie on nodes – water meter (one class) is at the end of each connection (second class)



Object, element, feature class

2. Topological dimension – topology check

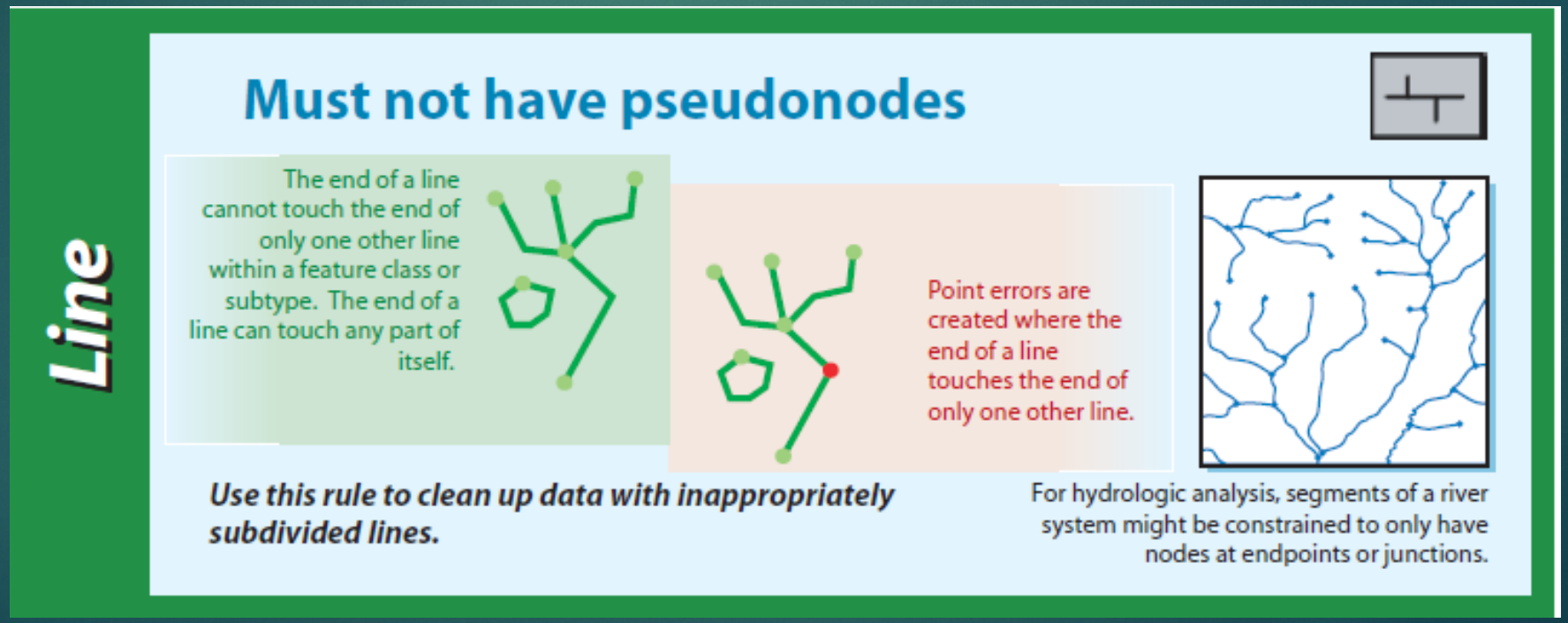
Line × points – each point must lie only on the end point of the line



Object, element, feature class

2. Topological dimension – topology check

Line × Nodes – it must not have nodes where only one line of the same class exits and enters – to clean the topology



Object, element, feature class

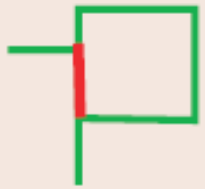
2. Topological dimension – topology check

Line – must not overlap itself

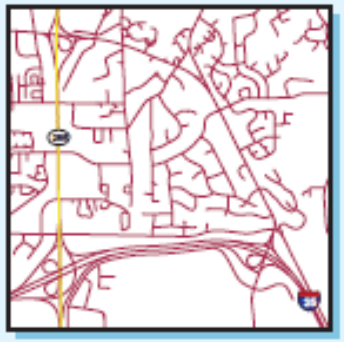
Line

Must not self overlap

Lines must not overlap themselves within a feature class or subtype. Lines can touch, intersect, and overlap lines in another feature class or subtype.



Line errors are created where lines overlap themselves.



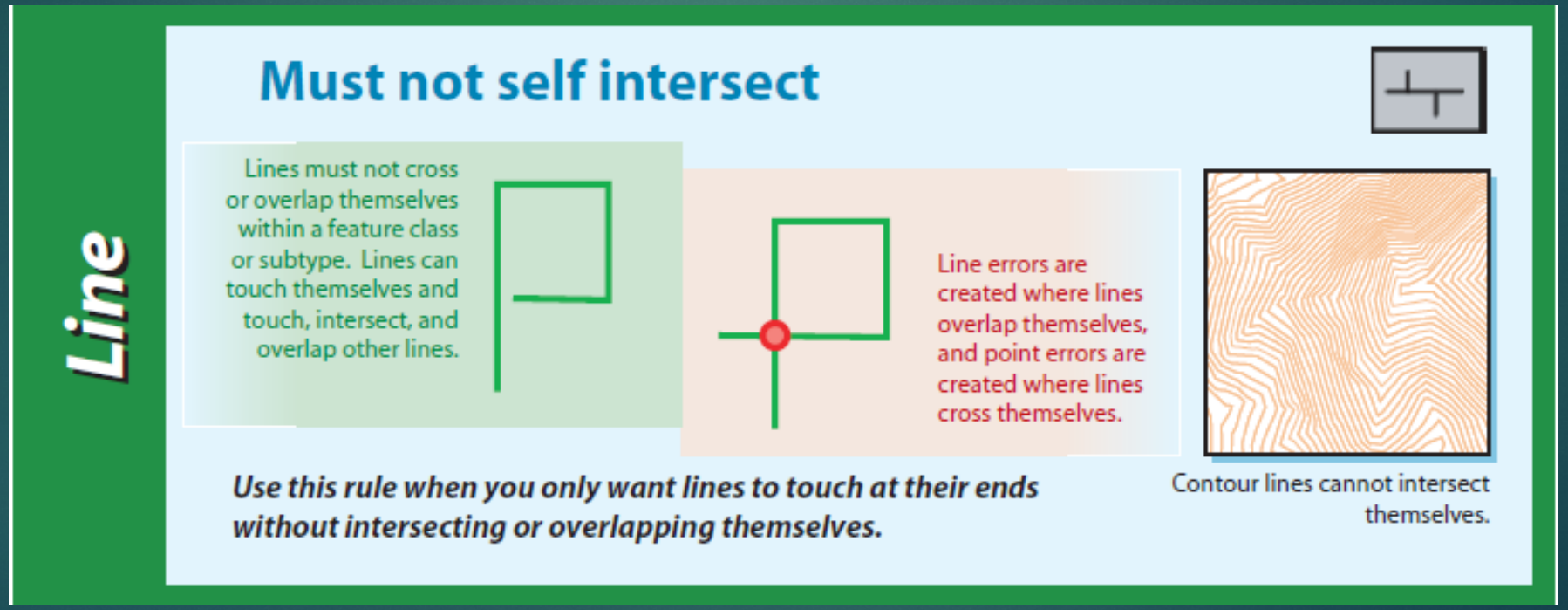
Use this rule with lines whose segments should never occupy the same space as another segment on the same line.

For transportation analysis, street and highway segments of the same feature should not overlap themselves.

Object, element, feature class

2. Topological dimension – topology check

Line – must not cross itself – a node must be inserted

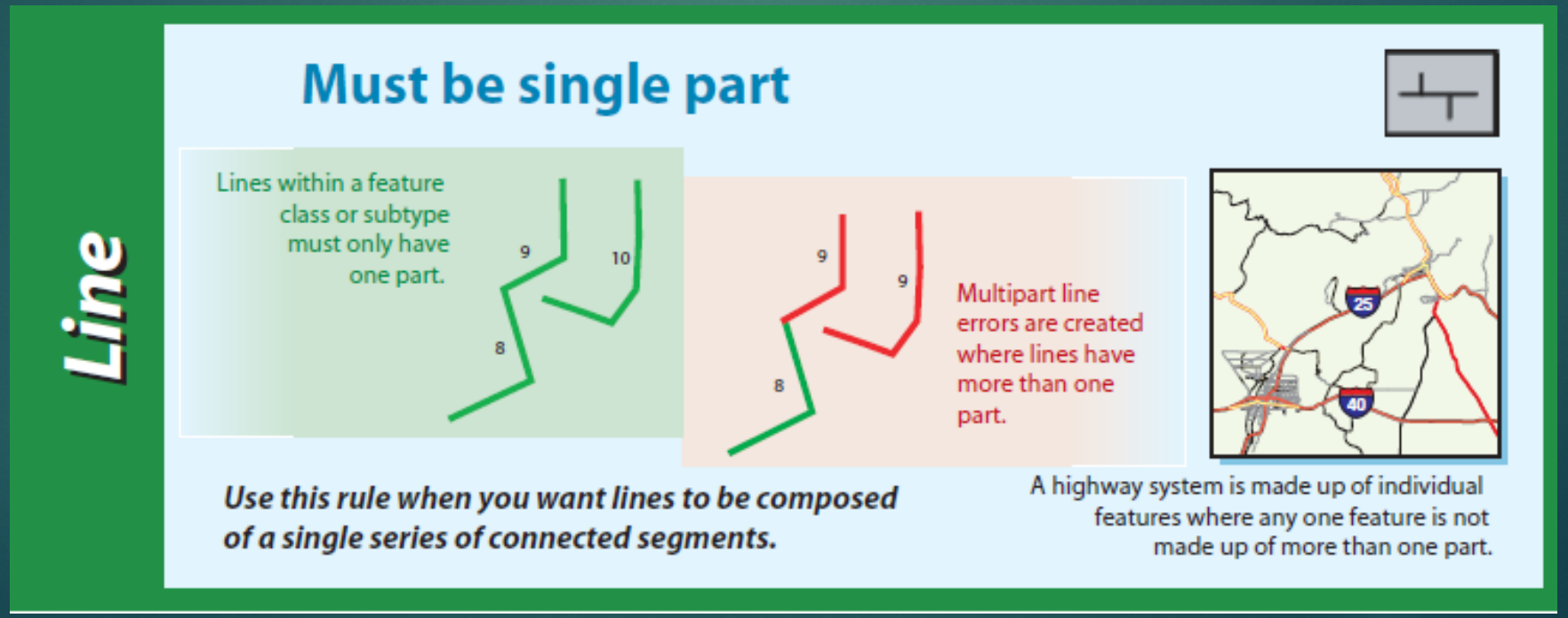


Object, element, feature class

2. Topological dimension – topology check

Lines – cannot have 2 separate lines marked as one continuous line

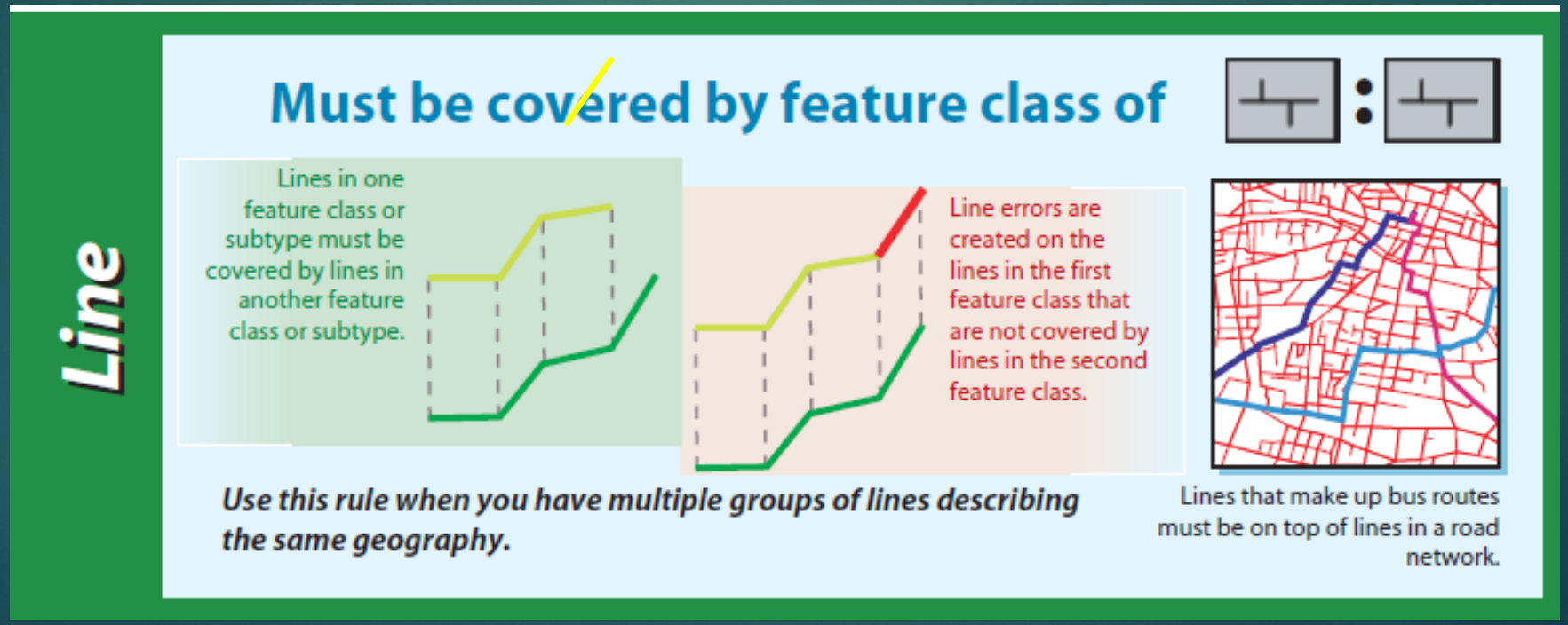
(line 8, 9, 10 on the left × 8, 9 and 9 on the right)



Object, element, feature class

2. Topological dimension – topology check

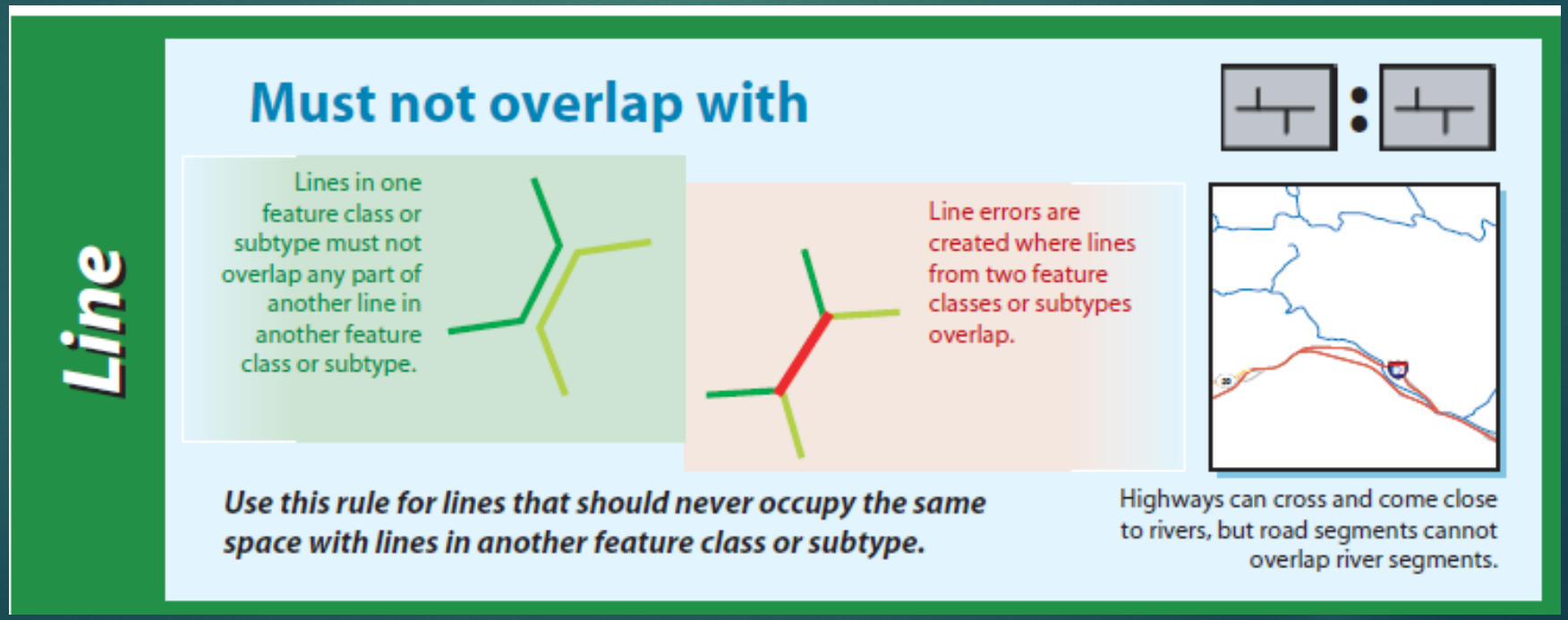
Line × line – for 2 different classes must have the same geometry
(a bus route is identical to the road network)



Object, element, feature class

2. Topological dimension – topology check

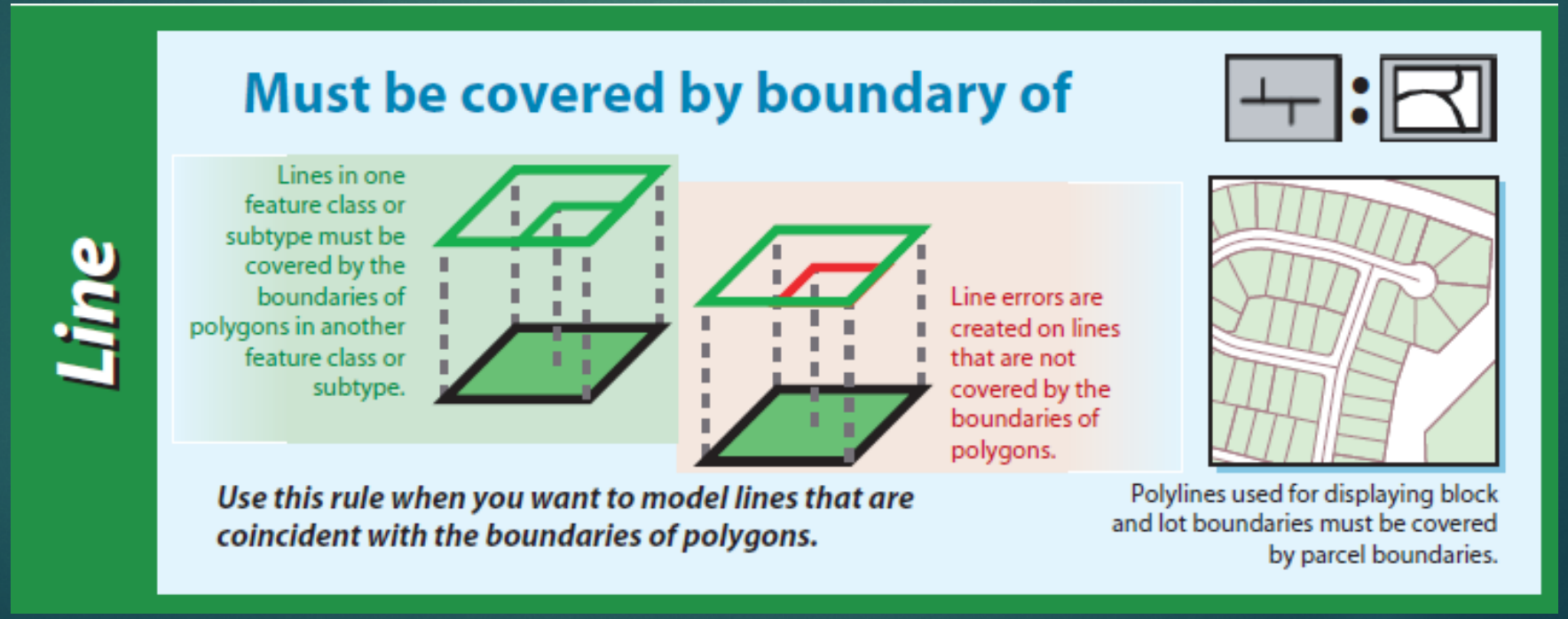
Line – the line of one class must not overlap the line of another class (the watercourse must not have the same position as the road adjacent to it)



Object, element, feature class

2. Topological dimension – topology check

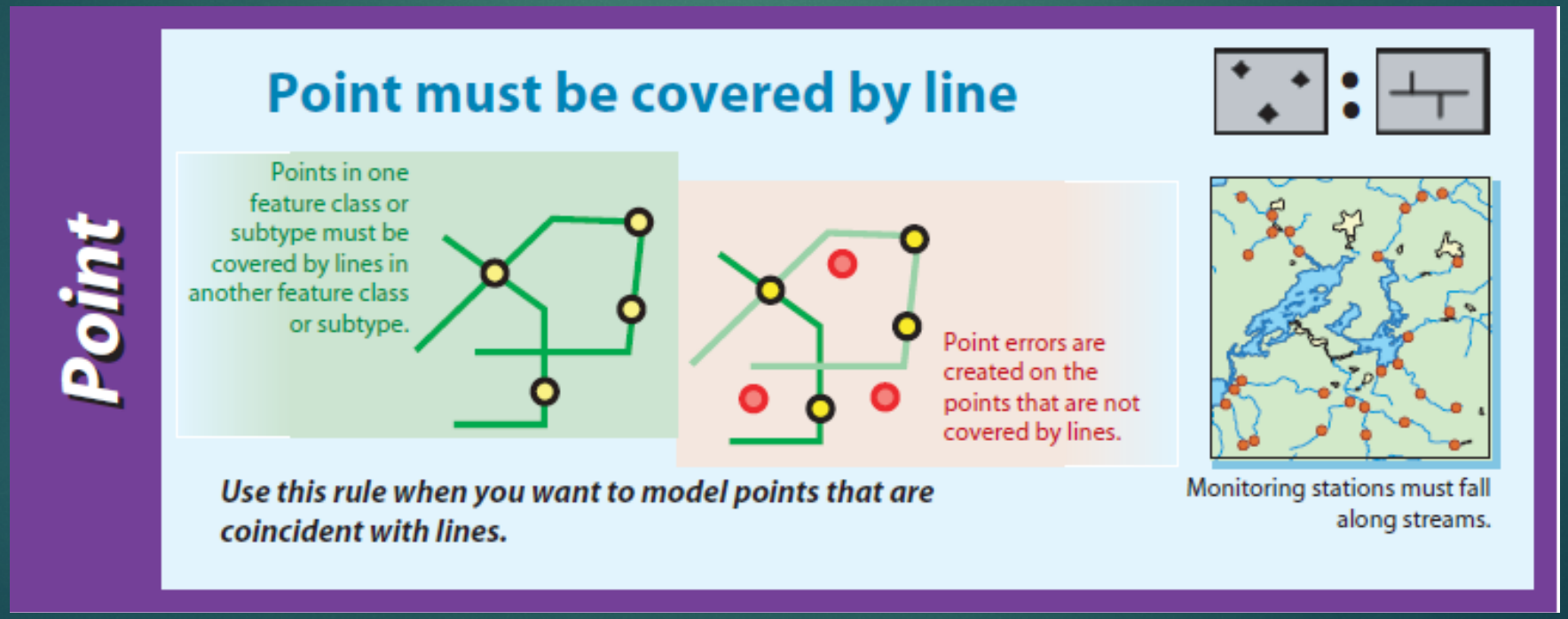
Lines × Polygons – the line must be covered by the boundary of the polygon



Object, element, feature class

2. Topological dimension – topology check

Points × Line – points must lie on a line



Object, element, feature class

3. **Attribute dimension** = descriptive data in GIS

Descriptive properties = **attributes** = descriptive data

- they specify individual elements – they define dimensionally or qualitatively properties = they represent the quality of the object,
- one method of measurement cannot be established for all

examples of attributes:

- *number of floors*
- *owner*
- *connection to the public water supply*
- *last fix*

Object, element, feature class
3. **Attribute dimension**

Attribute dimension is given by the number of attributes:

- at least one appears = the key attribute is marked
- maximum number of attributes is not limited
- each object has its own individual attribute values
- each object may not have all attribute values listed
- each class has its own list of attributes

Object , element, feature class

3. **Attribute Dimension: from class, entity and attribute records**

1 **class** is displayed in 1 table

1 **object** is displayed in 1 line

1 **attribute** (descriptive data) – listed in 1 column

key attribute = unique (often referred to as **ID** – see below)
must always be present for all entities, other attributes do not have to be and all values from 1 attribute do not

Attribute 1= ID	Attribute 2	Attribute 3	Attribute 4	Attribute 5
1	Vltava	280	…	…
2	Berounka	152	…	…
3	Labe	….	…	…

Object , element, feature class
3. **Attribute dimension: data type**

Attribute data type (value domain specification)

= Specifies applicable values for individual attributes (green)

- *Attribute* **data type**
- *number of floors* **= number (integer type)**
- *owner* **= text string (specify number of characters)**
- *connection to the public water supply* **= boolean type (yes/no)**
- *last fix* **= number (date type)**

Object, element, feature class
3. **Attribute dimension: data types**

data types

Automatic number

key attribute / primary key = base attribute that must be u
of each object for each class entered !!

Specifies uniqueness within a class that is unique in the database

An automatic number ensures the uniqueness of the key attribute –
from set as data type (=auto number)

Object, element, feature class

3. **Attribute dimension – descriptive data in GIS – data types**

Numeric data types

Number – can be used to checkmate. operation

subtypes :

1 . integer

integer (Integer = Smallint)

= **2 bytes** = 16 bits signed : $-½.2^{16}$, $+ ½.2^{16} – 1$

= 16 bits unsigned : 0, $+ 2^{16} – 1$

long integer = **4 bytes** = 32 bits :

–2,147,483,648 to + 2,147,483,647

For reference:

1 byte (byte) = 8 bits (0 – 255, $256 = 2^{8}$)

Object, element, feature class
3. **Attribute dimension – descriptive data in GIS – data types**

Numeric data types

2. Decimal number

single precision (single precision , FLOAT) = decimal number - positive and negative values

size 4 bytes = 32 bits, total number of values is 2^{32}

double precision = decimal number - positive and negative values
size 8 bytes = 64 bits, total number of values 2^{64}

more detailed decimal number -
size 12 bytes = 96 bits, total number of values 2^{96}

b-bit data takes up size b/8 flats

Object, element, feature class
3. **Attribute dimension – descriptive data in GIS – data types**

Numeric data types

3. other **numerical data types**

Date/time - date of birth, entry in the cadastre – DB machines can handle it (selects the dates of one month, adds a week, ...)

Currency – data with precision from 1 to 4 decimal places,

size 8 flats

Object , element, feature class
3. **Attribute dimension** = **descriptive data in GIS : domain**

Domain = definition of the values of individual attributes (including system coordinates):

eg domain: for year: can be 1900 – 2005,

for text: number of characters,

Reason: prevention of errors

prevention redundant data volume sizes

Object, element, feature class

3. **Attribute dimension** = **descriptive data in GIS**

Data type **Text string**

alphanumeric characters + other characters –

digits cannot be used for calculations

domain for text string -

- character limit,
- selection from a pre-prepared list of attribute values

Object, element, feature class

3. **Attribute dimension** = **descriptive data in GIS**

Data type BLOB – binary large objects

it is a long sequence of binary numbers – image or multimedia data

Object, element, feature class

3. **Attribute dimension** = **descriptive data in GIS**

Data type **Boolean**

only two possible values (=1-bit value, possible values: 0, 1):

Yes × No

Object, element, feature class
3. **Attribute dimension** = **descriptive data in GIS**

Descriptive data in GIS

- elements within one class – are different from each other *values of individual attributes*
- Based on attribute values, classes can either be split or merged
- The division into classes does not have to be immutable !
  - Pay attention to the division of area classes

Object, element, class of elements

4. **Graphic dimension** = **descriptive data in GIS - graphic attributes**

class **view** method:

point – symbol, size

line – line type, thickness, colour

polygon – line type for the border,
area filling (yes, no)
method of filling

Object, element, class of elements
5. **Time dimension**

Time changes of geoobjects = **dynamics**

- **time resolution** = determined by the GIS processor – different for different objects – geology × transport network × state of the atmosphere (time resolution)
- **chrono** = smallest time unit
- **time interval** = (time span) = set of time-ordered chronomes (time interval)

Object, element, feature class
time dimension **/dimension**

Kinds of time:

- **valid time** = moment of occurrence of the event (valid time)
- **transaction time** = time when the change is entered into the database (transaction time)
- **user time** = time if the event is used as data in the database system (user time)

Object, element, feature class

5. **Time dimension** -- spatio-temporal processes

Possible changes

- **change of position** = spatial limitation (spatial displacement) - changes geometry and maybe topology

- **spatial reduction (enlargement)** = (spatial expansion / reduction) - the topology does not need to be changed

- **changing attributes**

time in GIS – complex, difficult manipulation

Object, element, feature class
Summary – class definition

So the feature class is

the sum of elements (objects or phenomena) that are

- defined by a single set of attributes
- are of the same geometric type
- they may not always be displayed with the same graphic attribute

Ex. *cities,*
water courses,
local authorities,
construction completion date….

Object, element, feature class
summary
entity = element = phenomenon or object (specific element) or phenomenon

Entity (= **element**) in GIS must be:

- **identifiable** = distinguishable from others (**database**, **class** and **ID**)
- **relevant** = required for the given application (see section on **modelling**)
- **describable** = by its properties (choice **of attributes**)