Geometry shaders
(GLSL 1.20)

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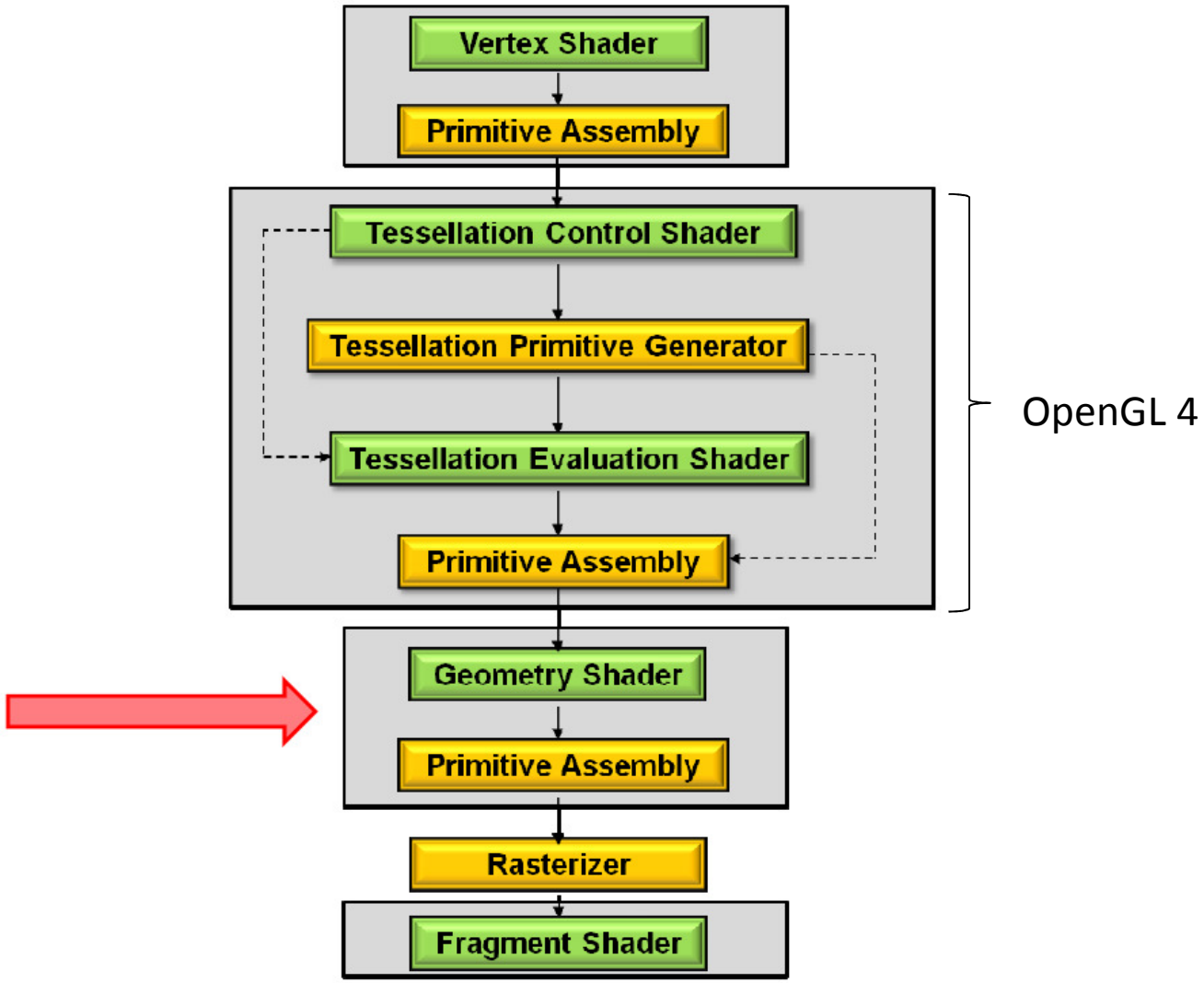
(*) Basades en el material de Mike Bailey

Introducció

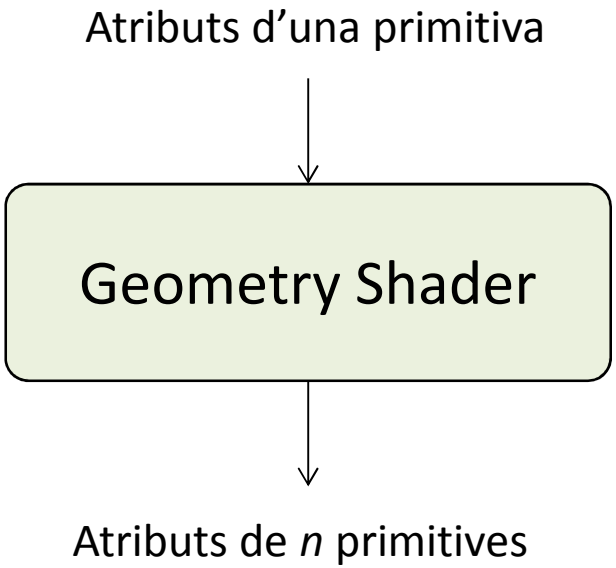
- Els GS processen **primitives** (punts, línies, triangles)
- Ofereixen la possibilitat de **crear noves primitives** i de canviar-ne la **topologia** (exemple: punt → triangle)
- Disponibles a partir d'OpenGL 2.1, GLSL 1.20.

Situació al pipeline

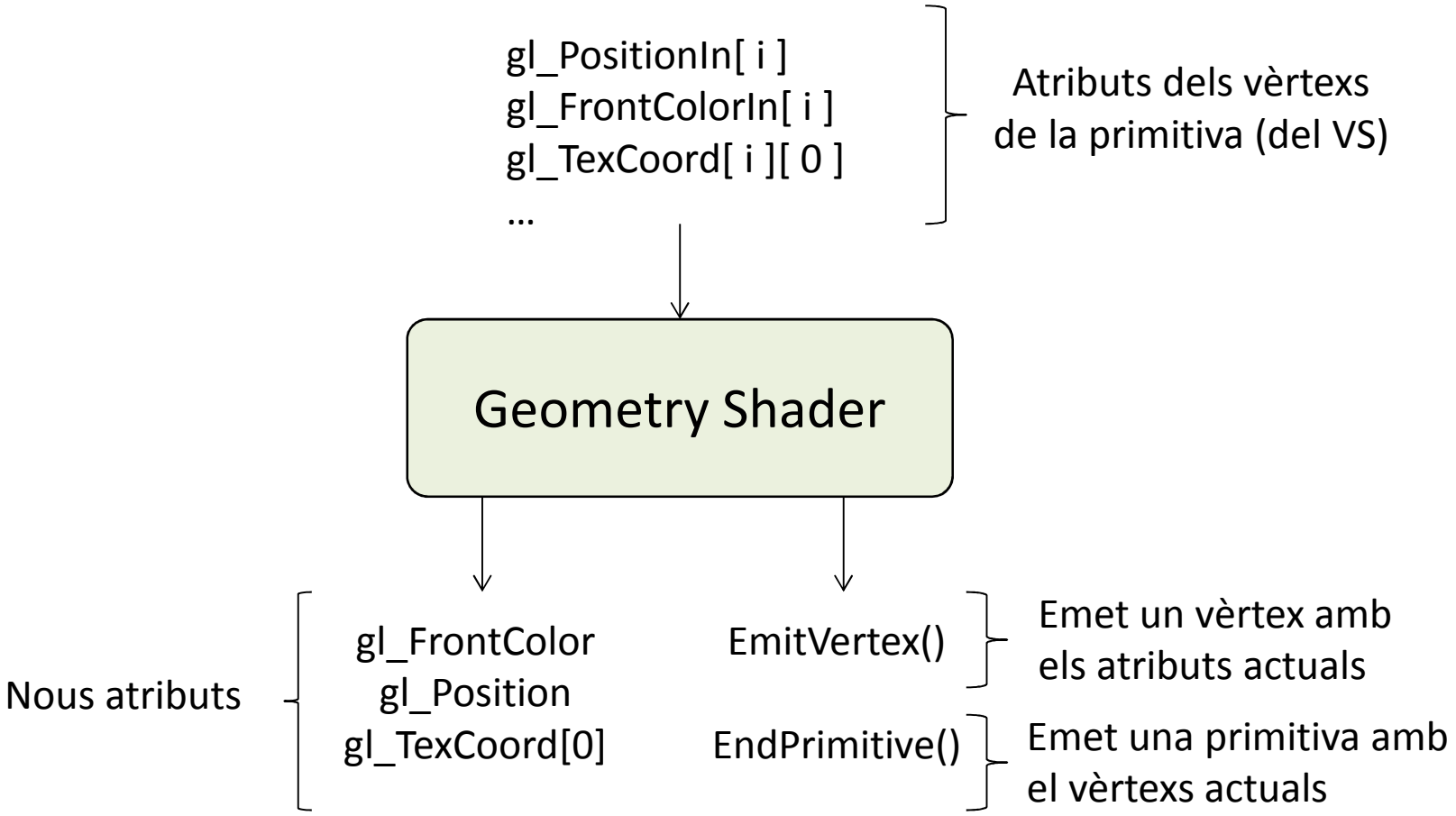


ENTORN D’EXECUCIÓ DEL GS

Entrades i sortides



Entrades i sortides

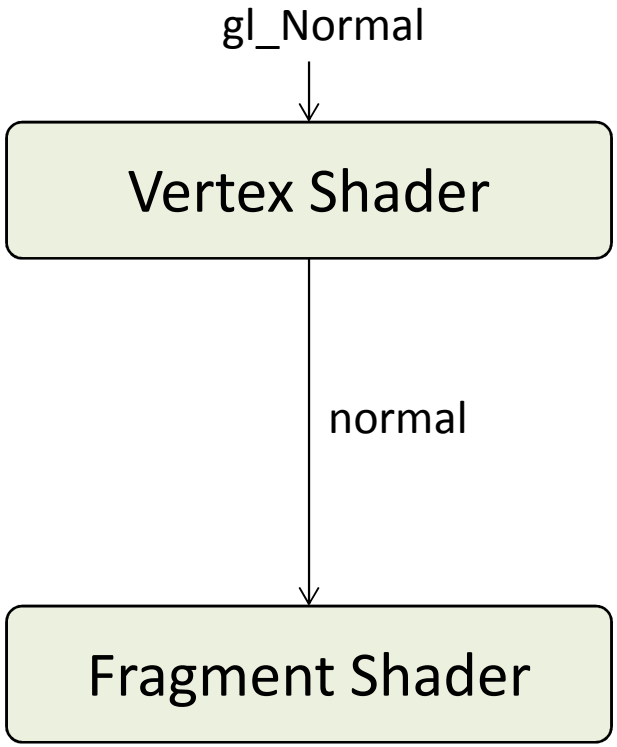


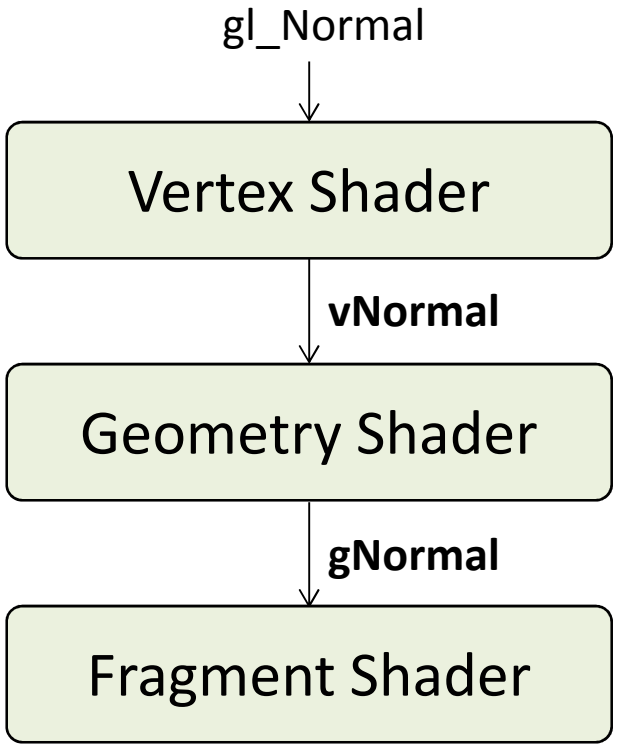
Reproducció del pipeline fix

```
// these lines enable the geometry shader support.
#version 120
#extension GL_EXT_geometry_shader4 : enable

void main( void )
{
    for(int i=0; i < gl_VerticesIn; i++)
    {
        gl_FrontColor  = gl_FrontColorIn[i];
        gl_Position    = gl_PositionIn  [i];
        gl_TexCoord[0] = gl_TexCoordIn  [i][0];
        EmitVertex();
    }
    EndPrimitive();   // implicit
}
```

1 (punts), 2 (linia), 3 (triangle)

Exemple: basic lighting v3 amb GS





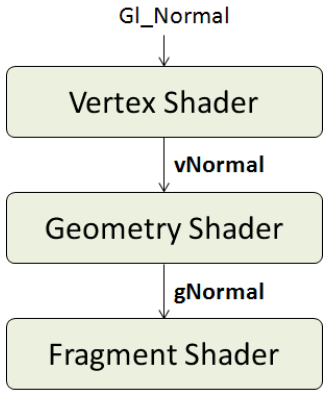
Exemple: basic lighting v3 amb GS

```
// basic-lighting-2.vert
varying vec3 normal;

void main() {
  normal = gl_N  malMatrix * gl_Normal;
  gl_Position =  ModelViewProjectionMat…
  gl_FrontColor  l_Color;
}
```

Del VS → FS

```
// basic-lighting-3.vert
varying vec3 vNormal;

void main() {
  vNormal = gl_N  malMatrix * gl_Normal;
  gl_Position = gl  odelViewProjectionMat…
  gl_FrontColor  _Color;
}
```

Del VS → GS



Exemple: basic lighting v3 amb GS

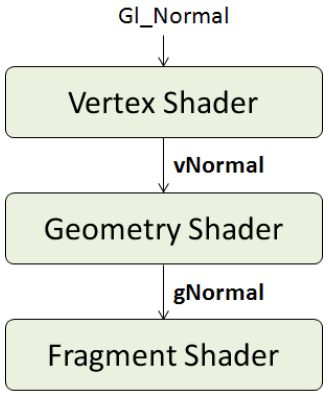
// basic-lighting-2.geom

Del VS → GS

Del GS → FS

// basic-lighting-3.geom

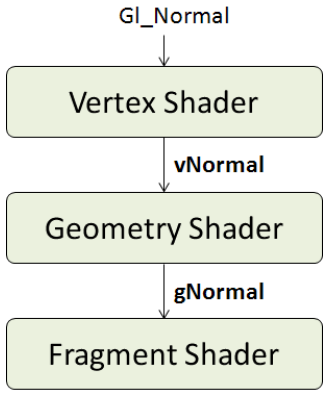
```
#version 120
#extension GL_EXT_geometry_shader4 : enable
varying in vec3 vNormal[3];
varying out vec3 gNormal;

void main( void )
{
  for( int i = 0 ; i < gl_VerticesIn ; i++ )
  {
    gNormal = vNormal[i];
    gl_FrontColor  = gl_FrontColorIn[i];
    gl_Position    = gl_PositionIn[i];
    EmitVertex();
  }
  EndPrimitive();
}
```



Exemple: basic lighting v3 amb GS

```
// basic-lighting-2.frag
varying vec3 normal;

void main()
{
   gl_FragColor = normal.z * gl_Color;
}
```

```
// basic-lighting-3.frag
varying vec3 gNormal;

void main()
{
   gl_FragColor = gNormal.z * gl_Color;
}
```

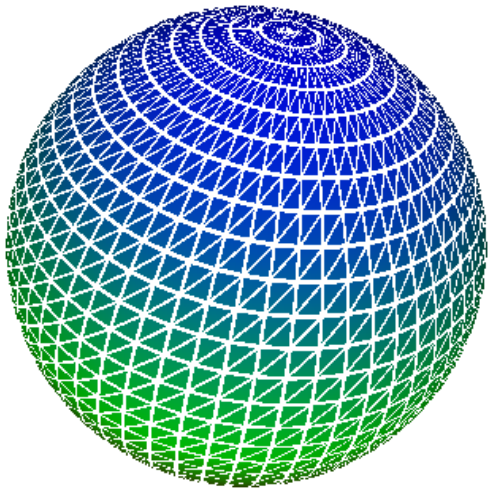


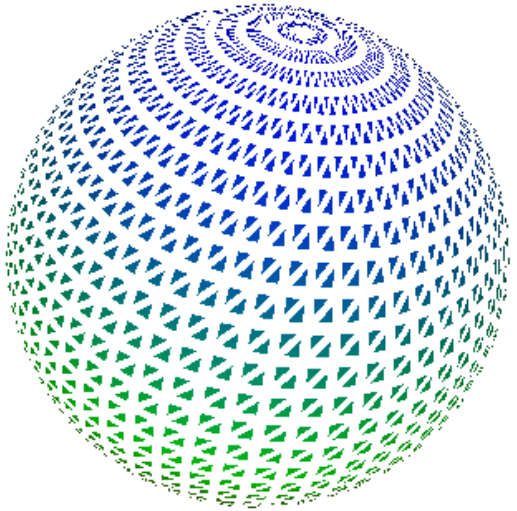
Observacions

- Si useu GS, els varying's del VS només arribaràn al FS si el GS els ha copiat.
- No hi ha cap BeginPrimitive(); és implícit
- No cal cridar EndPrimitive() al final del GS; també és implícit.

Exemple: encogir els triangles

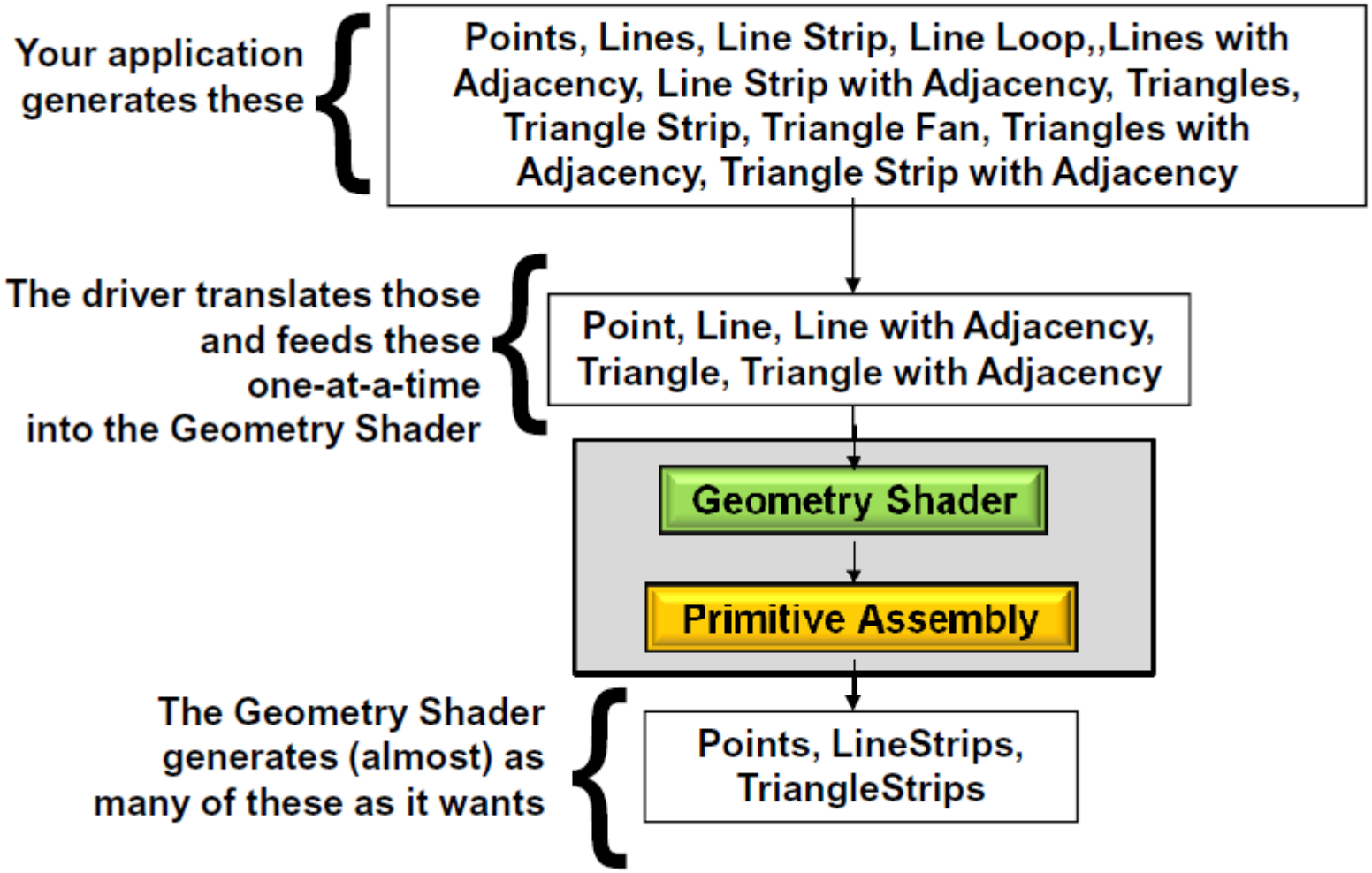
```
#version 120
#extension GL_EXT_geometry_shader4 : enable

in vec3 vNormal[];
varying vec3 gNormal;
uniform float shinkFactor;  // ex. 0.5

void main( void ) {
  vec4 center = (gl_PositionIn[0] + gl_PositionIn[1] + gl_PositionIn[2])/3.0;
  for( int i = 0 ; i < gl_VerticesIn ; i++ )
  {
    gNormal = vNormal[i];
    gl_FrontColor  = gl_FrontColorIn[i];
    gl_Position    = mix(gl_PositionIn[i], center, shinkFactor);
    EmitVertex();
  }
}
```





TIPUS DE PRIMITIVES

Primitives


Your application generates these
Points, Lines, Line Strip, Line Loop,,Lines with Adjacency, Line Strip with Adjacency, Triangles, Triangle Strip, Triangle Fan, Triangles with Adjacency, Triangle Strip with Adjacency
The driver translates those and feeds these one-at-a-time into the Geometry Shader
Point, Line, Line with Adjacency, Triangle, Triangle with Adjacency
Geometry Shader
Primitive Assembly
The Geometry Shader generates (almost) as many of these as it wants
Points, LineStrips, TriangleStrips

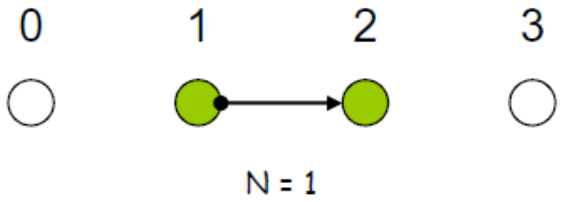
Primitives que envia l'aplicació

Primitives (glBegin…):

- GL_POINT
- GL_TRIANGLES
- …
- **GL_LINES_ADJACENCY**
- **GL_LINE_STRIP_ADJACENCY**
- **GL_TRIANGLES_ADJACENCY**
- **GL_TRIANGLE_STRIP_ADJECENCY**

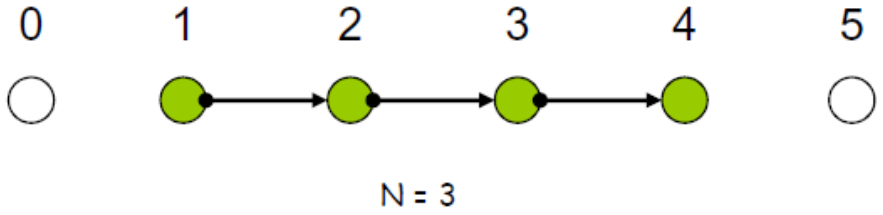
Adjacències - línies

Lines with Adjacency



4N vertices are given.
(where N is the number of line segments to draw).
A line segment is drawn between #1 and #2.
Vertices #0 and #3 are there to provide adjacency information.

Line Strip with Adjacency

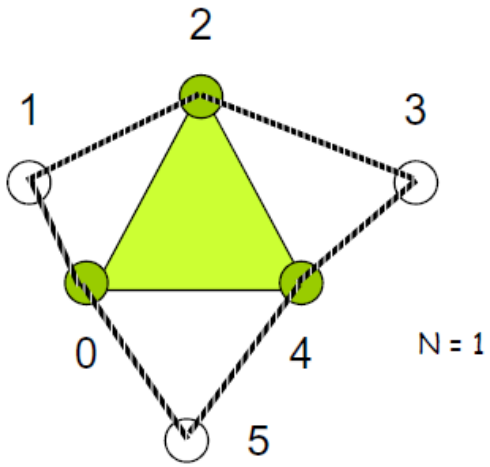


N+3 vertices are given
(where N is the number of line segments to draw).
A line segment is drawn between #1 and #2, #2 and #3, …, #N and #N+1.
Vertices #0 and #N+2 are there to provide adjacency information.

Adjacències - triangles

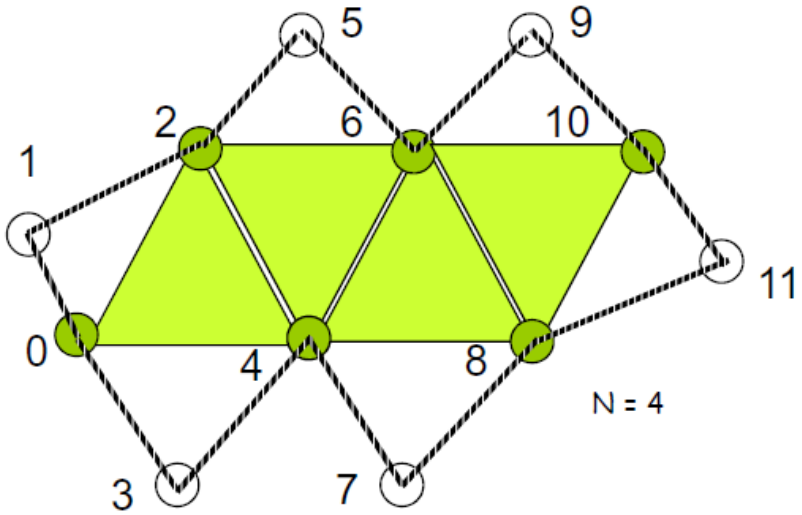
Triangles with Adjacency

6N vertices are given
(where N is the number of triangles to draw).
Points 0, 2, and 4 define the triangle.
Points 1, 3, and 5 tell where adjacent triangles are.



Triangle Strip with Adjacency

4+2N vertices are given
(where N is the number of triangles to draw).
Points 0, 2, 4, 6, 8, 10, …define the triangles.
Points 1, 3, 5, 7, 9, 11, … tell where adjacent triangles are.



Adjacències – gl_VerticesIn

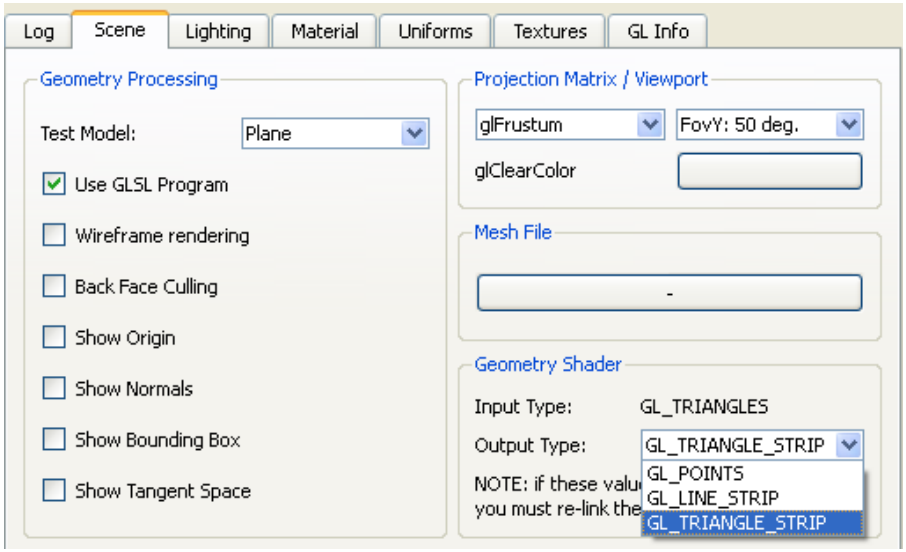
Número de vèrtexs que rep el GS:

- GL_POINTS → 1
- GL_LINES → 2
- GL_TRIANGLES → 3
- **GL_LINES_ADJACENCY → 4**
- **GL_TRIANGLES_ADJACENCY → 6**

Primitives que pot crear un GS

Un GS només pot generar:

- Punts (GL_POINTS)
- Segments (GL_LINE_STRIP)
- Triangles (GL_TRIANGLE_STRIP)



Exemple: explosió

Idea:

- Aplicar una translació variable a les cares.
- Eqüació bàsica MUA: $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$
- $\mathbf{r}_0$ serà la posició del centre
- $\mathbf{v}_0$ serà el vector posició del centre

Exemple: explosió

```
#version 120
#extension GL_EXT_geometry_shader4 : enable
uniform float time;
const vec3 a= vec3(0.0, -9.8, 0.0); // gravity
uniform float speed; // eg. 2.5 (glass.obj)
void main( void ) {
   float t = mod(time, 3.0); // repeat every 3 seconds
   vec4 center = (gl_PositionIn[0] + gl_PositionIn[1] + gl_PositionIn[2])/3.0;
   vec3 v0 = speed * center.xyz;
   vec4 trans = vec4(v0*t + 0.5*a*t*t, 0.0);
   for( int i = 0 ; i < gl_VerticesIn ; i++ ) {
      gl_Position = gl_ModelViewProjectionMatrix * (gl_PositionIn[i] + trans);
      EmitVertex();
   }
}
```