SO, YOU WANT TO BE A FRONT-END ENGINEER

StirTrek 2012,
@dmosher

Sheet #1218 of 9189. Patent #2398123

"DEV"OLUTION

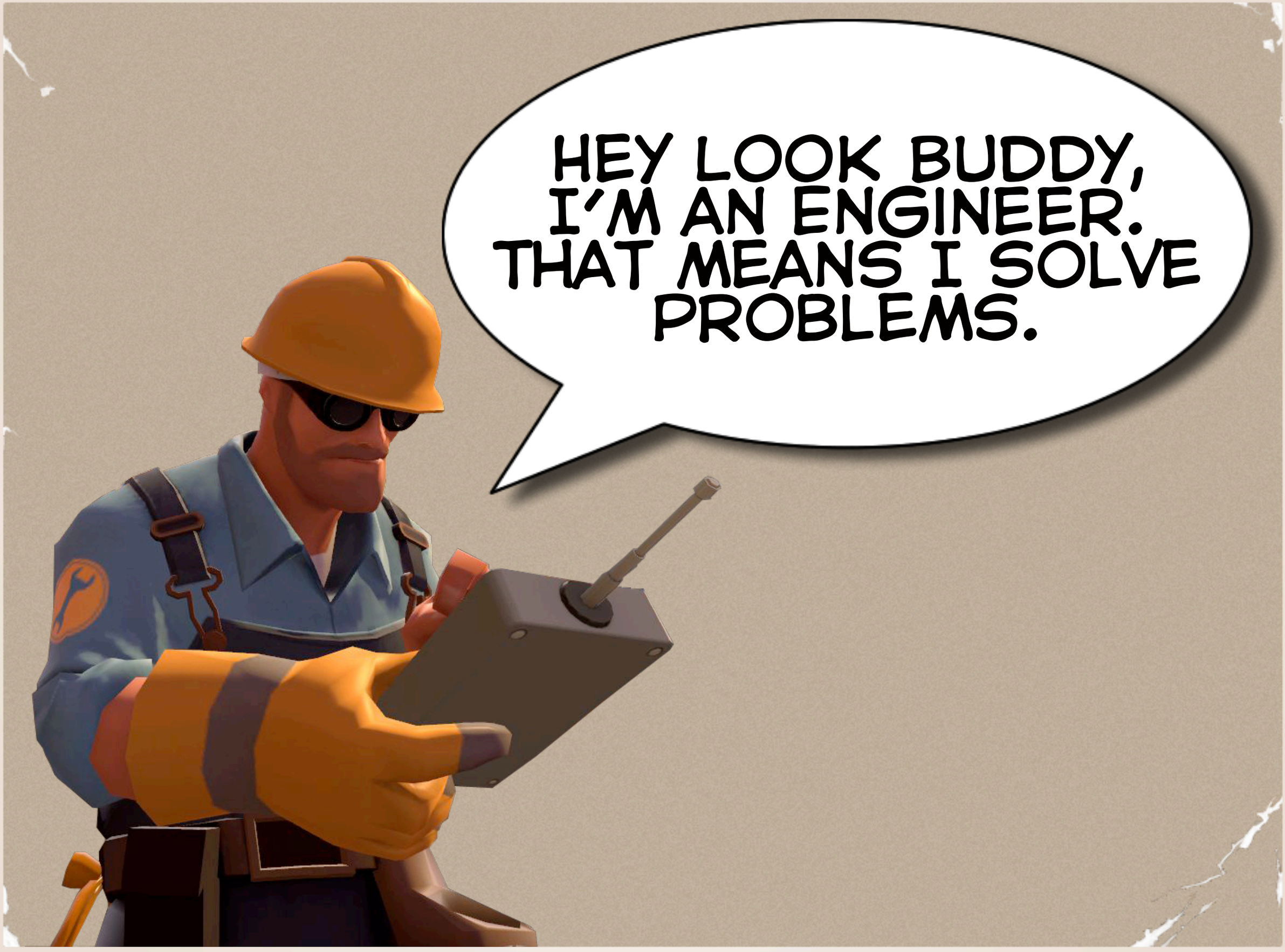
designer

hacker

developer

engineer

Sheet #1218 of 9189. Patent #2398123



http://www.youtube.com/watch?v=ipYkuCZ2IYI

http://bit.ly/how-browsers-work

Tali Garsiel & Paul Irish

LESSON PLAN

1. Understand Browsers

2. Understand Best Practices

BROWSERS

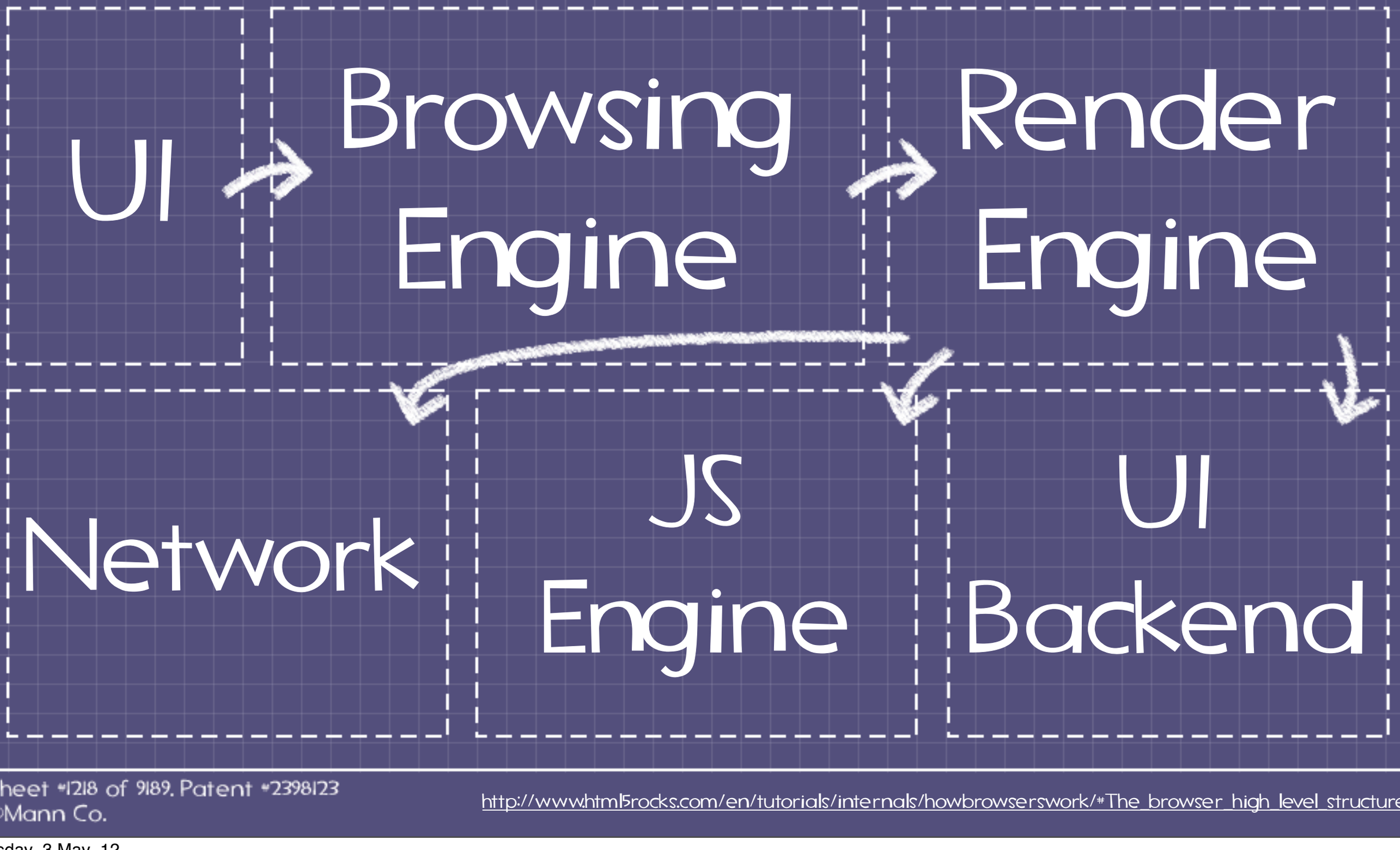
>> THE MOST VOLATILE PROGRAMMING ENVIRONMENT THE WORLD HAS EVER KNOWN.

PAUL IRISH

"As a web developer, learning the internals of browser operations helps you make better decisions and know the justifications behind development best practices."

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/

BROWSERS:



Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_browser_high_level_structure

MAIN FLOW:

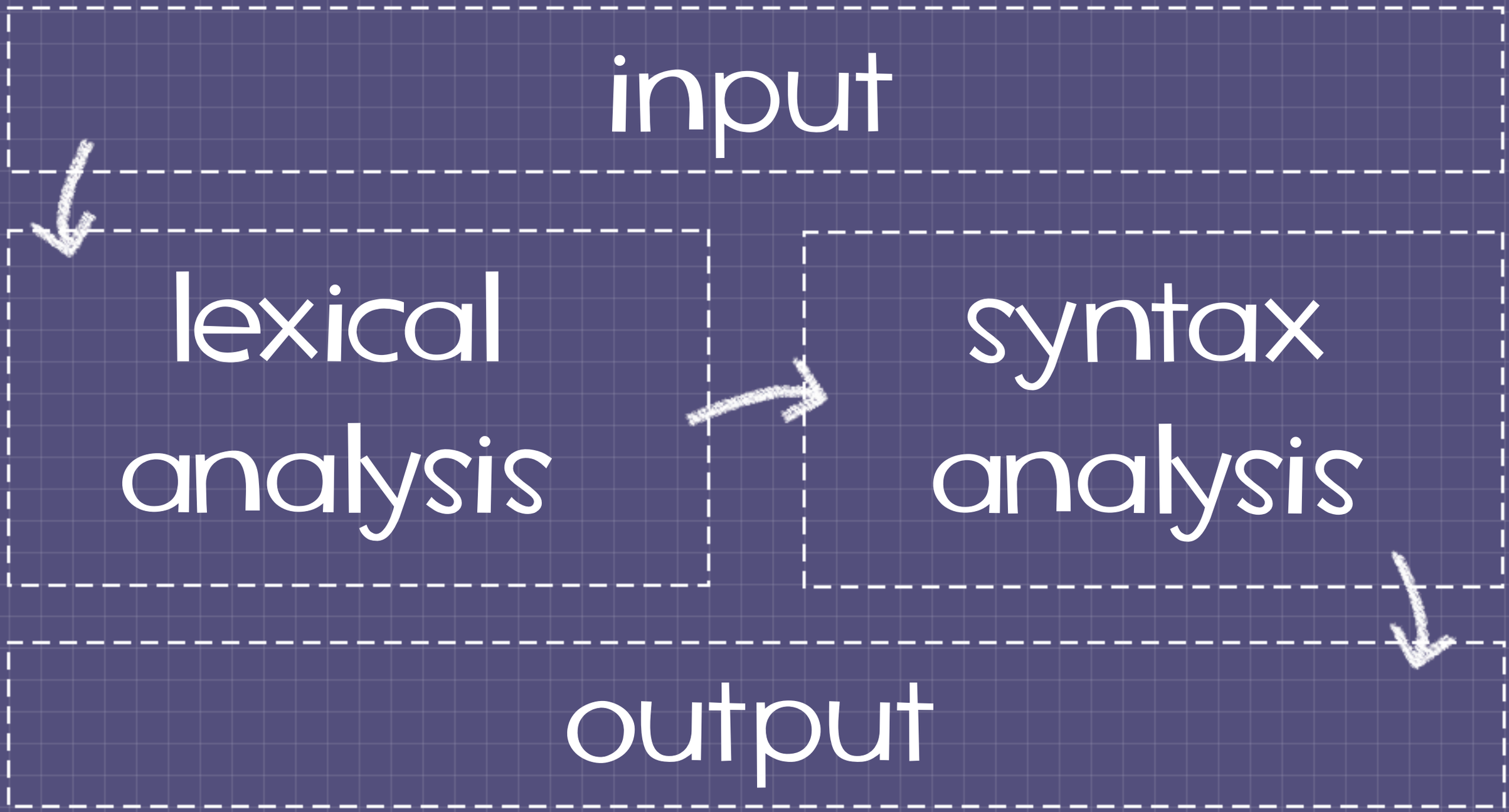
Parse HTML → DOM Tree → Render Tree → Layout & Paint

THE RENDERING ENGINE REQUESTS THE DOCUMENT IN 8K CHUNKS FROM THE NETWORK LAYER.

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_main_flow

PARSING IN GENERAL:



Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Grammars

PARSING: A SIMPLE EXAMPLE

```
<symbol> ::= __expression__
```

```
input: 2 + 3 - 1
```

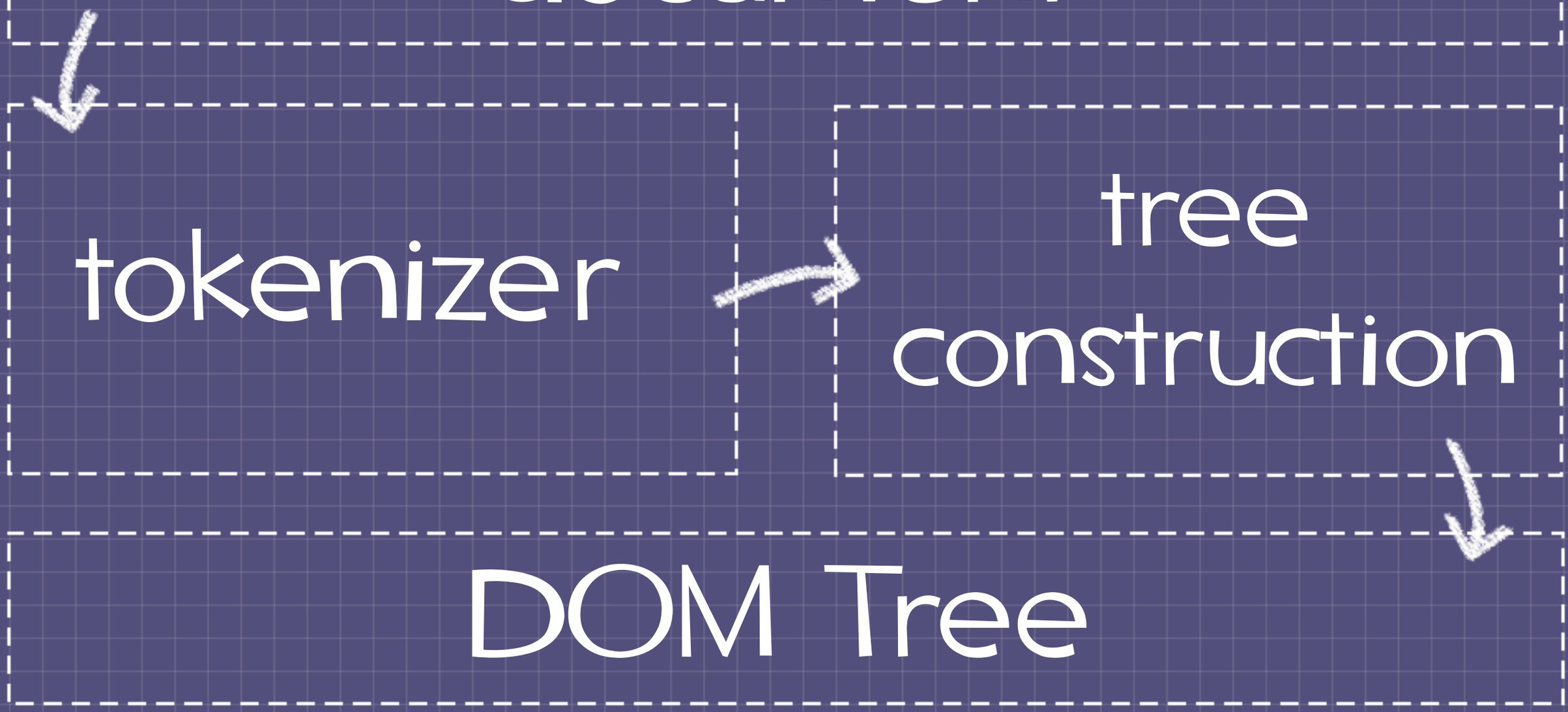
```
INTEGER :0|[1-9][0-9]*
PLUS : +
MINUS : -
```

```
expression := term operation term
operation := PLUS | MINUS
term := INTEGER | expression
```

http://en.wikipedia.org/wiki/Backus-Naur_Form

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#context_free_grammar

PARSING HTML:



Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Grammars

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#context_free_grammar

HTML DEFINITION:

HTML DTD.html

```
1  <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN" "http://www.w3.org/TR/html4/strict.dtd">
2  <html lang="ru">
3  <head>
4    <title>Stir Trek - May the 4th Be With You</title>
5    <meta http-equiv="Content-Type" content="text/html;charset=UTF-8">
6  </head>
7  <body>
8    <p>
9      Hello World
10   </p>
11   <div> <img src="example.png"/></div>
12 </body>
13 </html>
```

Line: 11 Column: 39 HTML Zen Soft

VOCABULARY AND SYNTAX OF HTML ARE DEFINED IN SPECS CREATED BY THE W3C.

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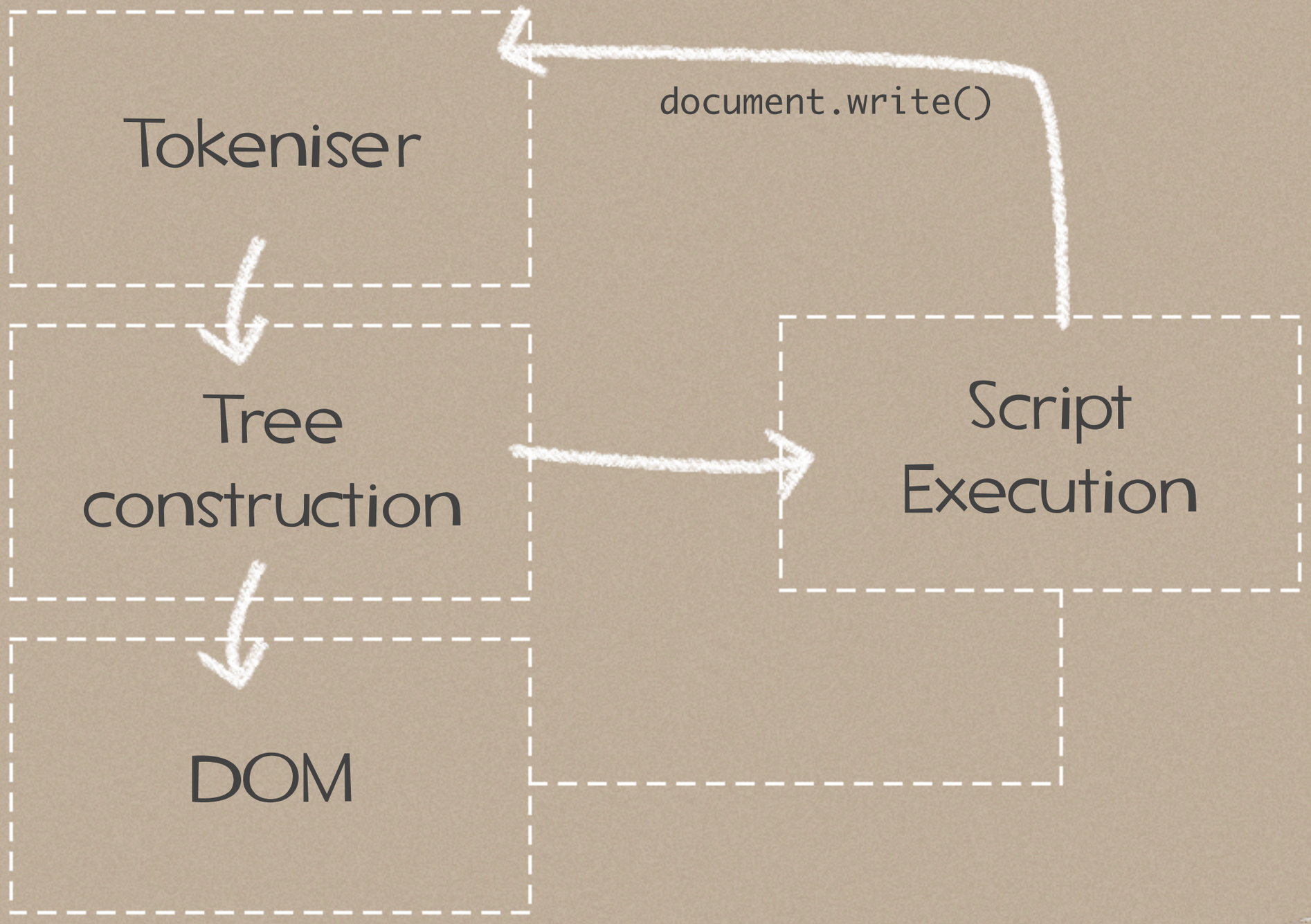
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#HTML_DTD

PARSING ALGORITHM

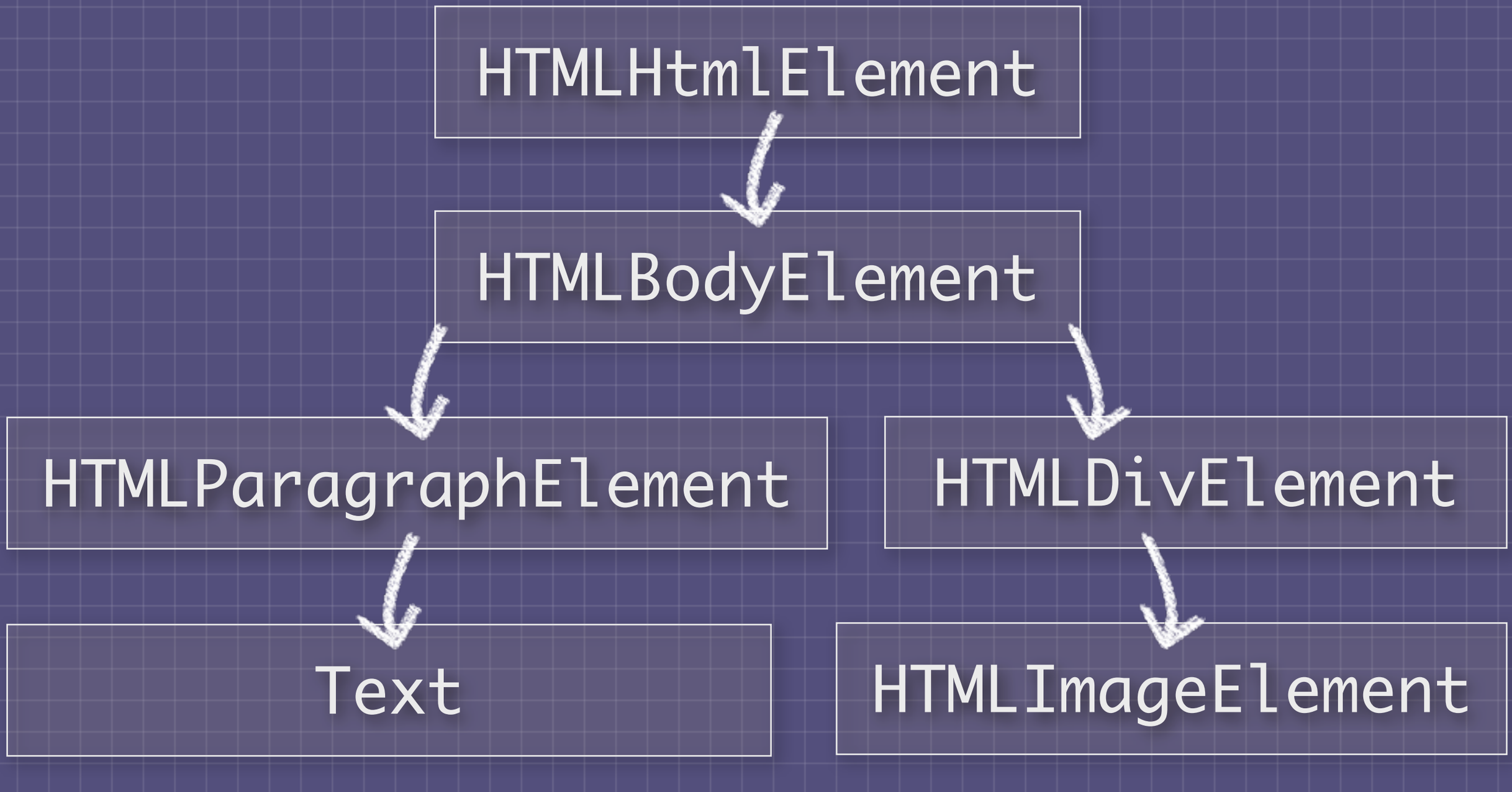


http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_tokenization_algorithm

BEST PRACTICE

MOVE SCRIPTS TO THE BOTTOM OF THE PAGE

DOCUMENT OBJECT MODEL:



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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#DOM

PARSING HTML:

FORGIVING CONTINUOUS COMPLEX

MAIN FLOW:

Parse HTML → DOM Tree → Render Tree → Layout & Paint

YOU NEVER GET "INVALID SYNTAX" ERRORS ON AN HTML PAGE. BROWSERS FIX INVALID CONTENT AND MOVE ON.

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_main_flow

PARSING CSS:

Flex / Bison → Stylesheet Object

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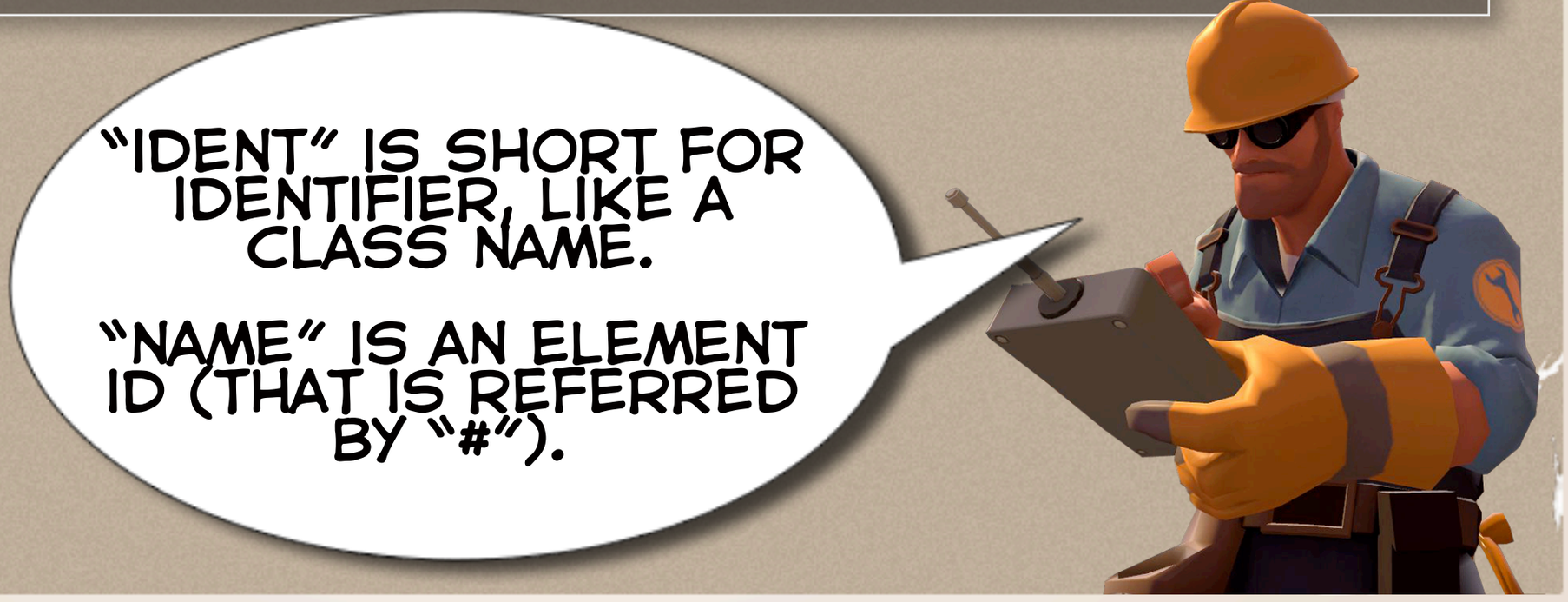
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#CSS_parsing

PARSING CSS MUCH EASIER.

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#CSS_parsing

CSS VOCABULARY

```
comment     \/\*[^*]*\*+([^/*][^*]*\*+)*\/
num         [0-9]+|[0-9]*”.”[0-9]+
nonascii    [\200-\377]
nmstart     [_a-z]|{nonascii}|{escape}
nmchar      [_a-z0-9-]|{nonascii}|{escape}
name        {nmchar}+
ident       {nmstart}{nmchar}*
```



http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#CSS_parsing

CSS GRAMMAR

```
ruleset
    : selector [ ',' S* selector ]*
      '{' S* declaration [ ';' S*declaration ]* '}' S*
    ;
selector
    : simple_selector [ combinator selector | S+ [ combinator? selector ]? ]?
    ;
simple_selector
    : element_name [ HASH | class | attrib | pseudo ]*
    | [ HASH | class | attrib | pseudo ]+
    ;
class
    : '.' IDENT
    ;
element_name
    : IDENT | '*'
    ;
attrib
    : '[' S* IDENT S* [ [ '=' | INCLUDES | DASHMATCH ] S*
      [ IDENT | STRING ] S* ']'
    ;
pseudo
    : ':' [ IDENT | FUNCTION S* [IDENT S*] ')' ]
    ;
```

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#CSS_parsing

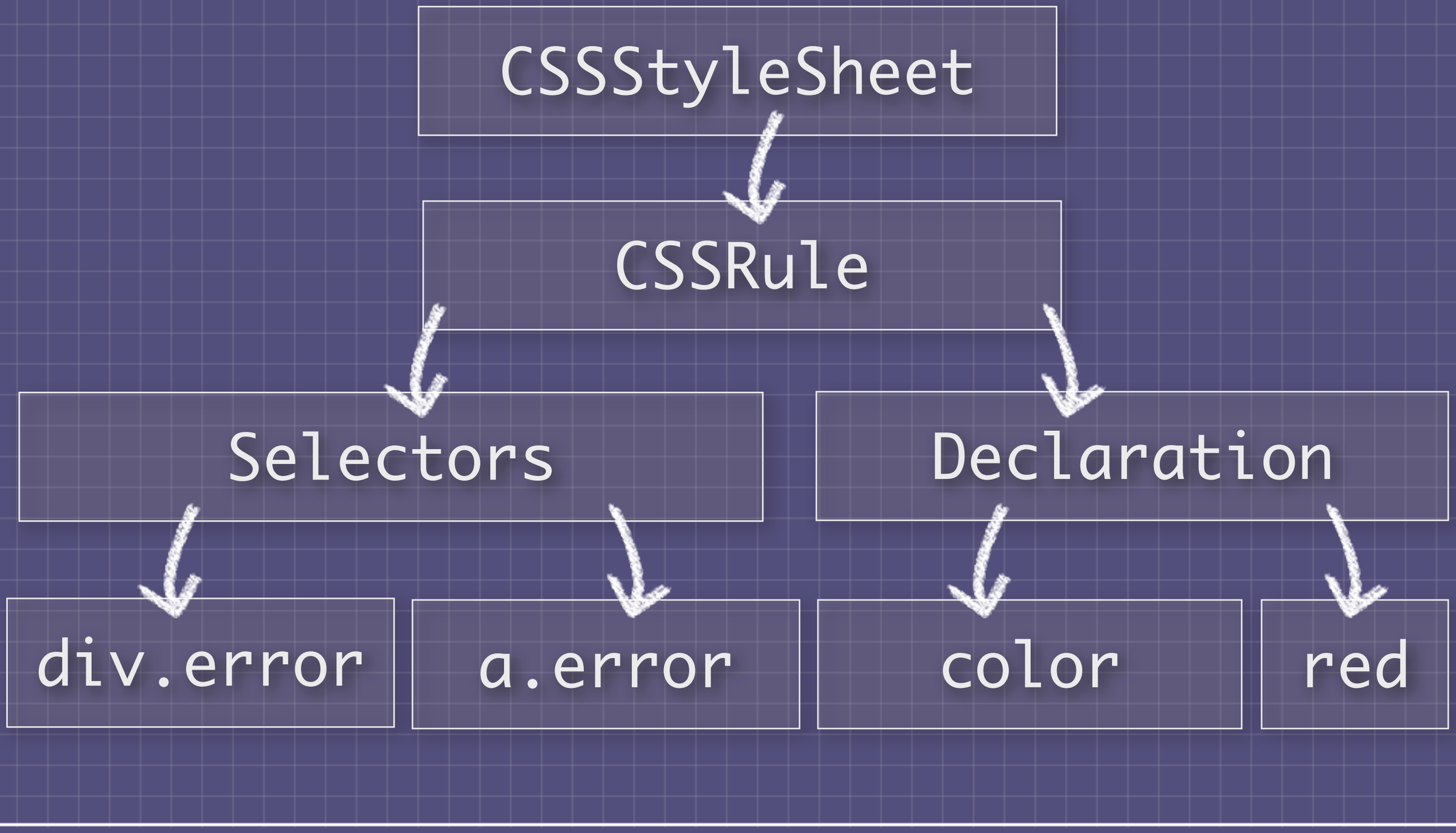
RULESET DEFINITION

```
ruleset
    : selector [ ‘,’ S* selector ]*
      ‘{‘ S* declaration [ ‘;’ S*declaration ]* ‘}’ S*
    ;
```

```
div.error, a.error {
  color: red;
  font-weight: bold;
}
```

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#CSS_parsing

STYLESHEET OBJECT:



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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#DOM

PARSING CSS:

AUTOMATIC SINGLE PASS SIMPLE

PROCESSING RESOURCES:

Synchronous	Speculative
Order Matters	Single Threaded*

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_order_of_processing_scripts_and_style_sheets

REGARDING PROCESSING ORDER....

BROWSERS ARE SYNCHRONOUS

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_order_of_processing_scripts_and_style_sheets

BROWSERS ARE SINGLE THREADED?

BROWSERS RENDER IN A SINGLE THREAD

THE EVENT LOOP

```
while (!mExiting)
    NS_ProcessNextEvent(thread);
```

THE BROWSER MAIN THREAD IS AN INFINITE EVENT LOOP THAT KEEPS THE PROCESS ALIVE. IT WAITS FOR EVENTS AND PROCESSES THEM.

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Event_loop

I HAVE A SINGLE MAIN THREAD THAT HANDLES PROCESSING OF EVENTS IN AN EVENT LOOP.

I HAVE A SEPARATE MAIN THREAD THAT LIVES IN A PROCESS FOR EACH TAB THAT IS OPENED.

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_rendering_engines_threads

EVERYTHING EXCEPT NETWORK OPERATIONS HAPPENS IN A SINGLE THREAD

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_rendering_engines_threads

SPECULATIVE PARSING:

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Speculative_parsing

WHAT IF MY SCRIPTS ASK FOR STYLE INFORMATION DURING PARSING?

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_order_of_processing_scripts_and_style_sheets

I BLOCK ALL SCRIPTS WHEN A STYLE SHEET IS BEING LOADED AND PARSED.

I BLOCK SCRIPTS ONLY WHEN THEY TRY TO ACCESS CERTAIN STYLE PROPERTIES THAT MAY BE AFFECTED BY UNLOADED STYLESHEETS.

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Speculative_parsing

PARSING RECAP:

SPECULATIVE SYNCHRONOUS ORDER MATTERS SINGLE THREADED*

RENDER TREE:

```
class RenderObject {
  virtual void layout();
  virtual void paint(PaintInfo);
  virtual void rect repaintRect();
  Node* node;                    //the DOM node
  RenderStyle* style;            // computed style
  RenderLayer* containingLayer; // containing z-index layer
}
```

EACH RENDERER REPRESENTS A RECTANGULAR AREA USUALLY CORRESPONDING TO THE NODES CSS BOX AS DESCRIBED BY THE CSS2 SPEC.

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Render_tree_construction

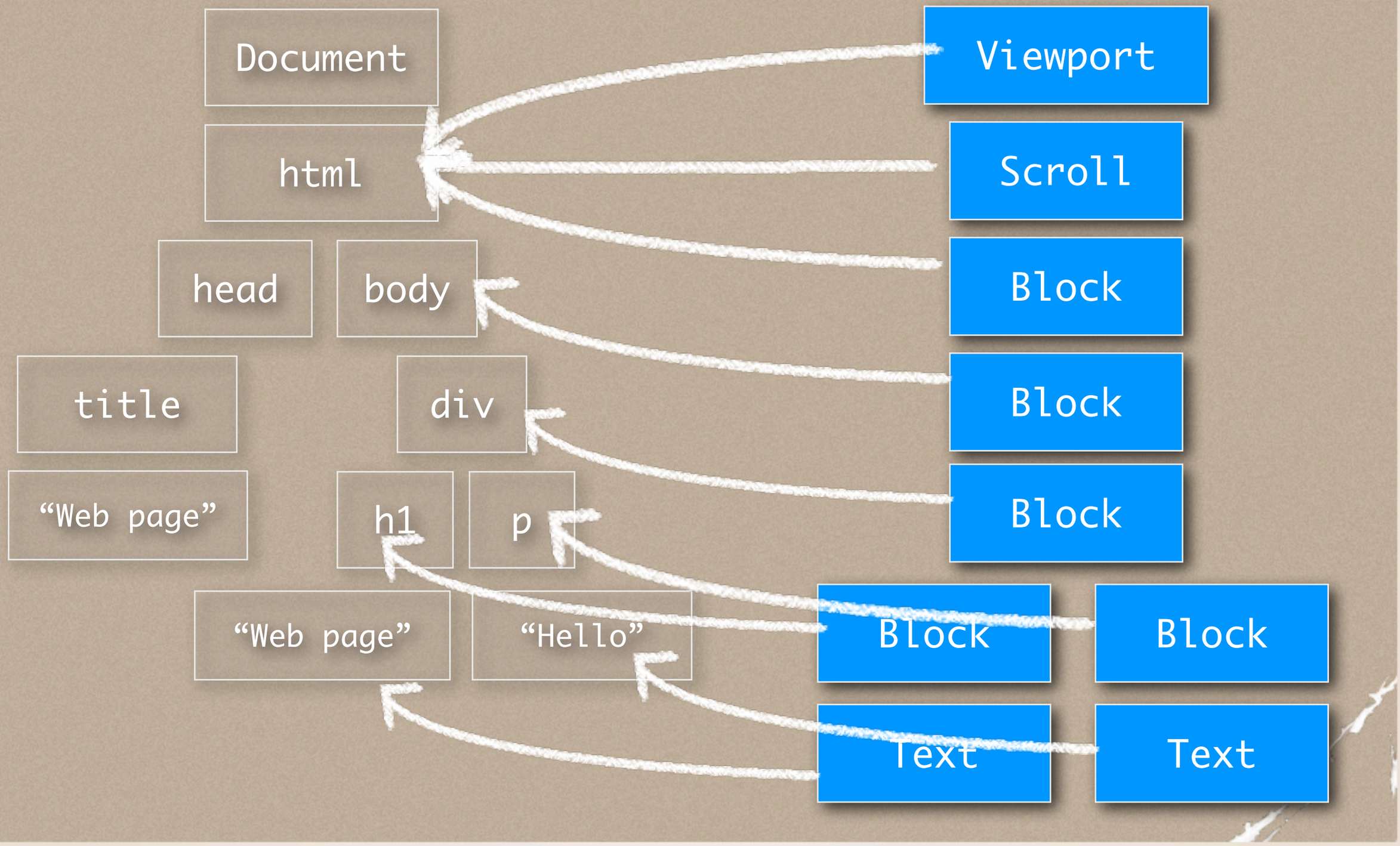
NODE "DISPLAY":

```
switch (style->display) {
  case NONE:
    break;
  case INLINE:
    o = new (arena) RenderInline(node);
    break;
  case BLOCK:
    o = new (arena) RenderBlock(node);
    break;
  case INLINE_BLOCK:
    o = new (arena) RenderBlock(node);
    break;
  case LIST_ITEM:
    o = new (arena) RenderListItem(node);
    break;
  ...
}
```

Sheet #1218 of 9189, Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Render_tree_construction

DOM TREE VS RENDER TREE:



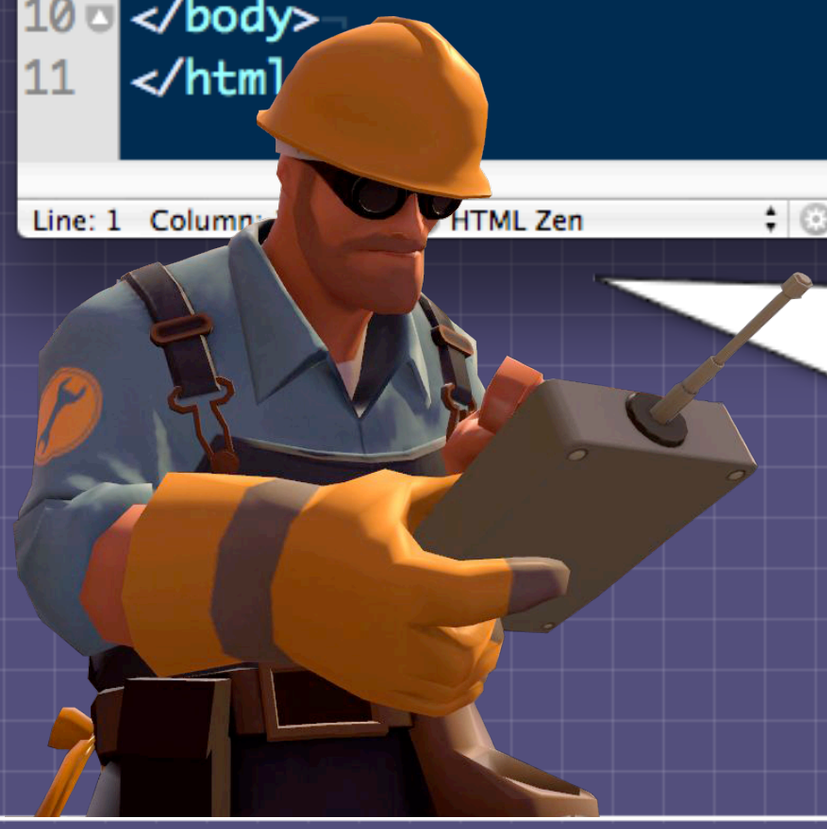
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Render_tree_construction

STYLE COMPUTATION:

styles.html

```
1  <!DOCTYPE HTML>
2  <html lang="en-US">
3  <head>
4    <meta charset="UTF-8">
5    <title>Style Computation</title>
6    <link rel="stylesheet" type="text/css" href="style.css" media="all" />
7  </head>
8  <body bgcolor="#000333">
9    <p style="line-height: 10px;">I have an inline style attribute.</p>
10 </body>
11 </html>
```

Line: 1 Column: HTML Zen Soft Tab



STYLE INFORMATION COMES FROM BROWSER STYLE SHEETS, USER STYLE SHEETS, AUTHOR STYLE SHEETS, INLINE STYLES AND VISUAL PROPERTIES (BGCOLOR)

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#style_computation

STYLE COMPUTATION IS VERY HARD

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_order_of_processing_scripts_and_style_sheets

STYLE COMPUTATION:

1. STYLE DATA IS VERY LARGE
2. RULE MATCHING IS HEAVY
3. CASCADE IS COMPLEX

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#style_computation

STYLE SOURCES

Browser

User

Author

Inline

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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#The_order_of_processing_scripts_and_style_sheets

CASCADE PRIORITY:

(low) Priority (high)

Browser

Normal

Important

Sheet #1218 of 9189. Patent #2398123

the-css-cascade.pdf

BEST PRACTICE

Don't use CSS Resets.

(if you must, use normalize.css)

necolas.github.com/normalize.css/

CASCADE PRIORITY:

(low) Priority (high)

Browser

Normal

User

Author

Important

Author

User

Sheet #1218 of 9189. Patent #2398123

the-css-cascade.pdf

BEST PRACTICE

LIMIT !IMPORTANT;

bit.ly/css-best-practices

ANATOMY OF A RULE:

```
h2 {
    color: blue;
    margin: 1em;
}
```

selector

declaration

property

value

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the-css-cascade.pdf

BROWSERS HAVE TO DEAL WITH CONFLICTING CSS RULES

the-css-cascade.pdf

SPECIFICITY:

a = inline	<p style=>
b = ids	#footer
c = classes	.error
d = element	div, p, a

a > b > c > d

Sheet *1218 of 9189. Patent *2398123
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the-css-cascade.pdf

SPECIFICITY:

```
h2 {
    color: blue;
    margin: 1em;
}
```

```
d = element
```

```
specificity: 0001 (abcd)
```

Sheet #1218 of 9189. Patent #2398123
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the-css-cascade.pdf

SPECIFICITY:

```
#header .island a {
    color: blue;
    margin: 1em;
}
```

```
id(1)+class(1)+element(1)
```

```
specificity: 0111 (abcd)
```

BEST PRACTICE

"Classes are your friends. Seeing a lot of IDs is very bad. Try to find the middle ground where all the repeating visual patterns can be abstracted. Also, keep specificity as low as possible."

@STUBORNELLA

http://bit.ly/css-best-practices

WHAT IF MULTIPLE RULES HAVE THE SAME SPECIFICITY?

the-css-cascade.pdf

CONFLICT RESOLUTION:

1. Importance (!important)
2. Origin (Author, User, Browser)
3. Specificity (ABCD)
4. Source Order

the-css-cascade.pdf

RULE OF THUMB

if two declarations have the same importance, origin and specificity, the latter specified declaration wins

the-css-cascade.pdf

MAIN FLOW:

Parse HTML → DOM Tree → Render Tree → Layout & Paint

CALCULATING POSITION AND SIZE OF RENDERERS IS CALLED LAYOUT OR REFLOW.

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

http://www.youtube.com/watch?v=dndeRnzkJDU

THE LAYOUT PROCESS

1. Parent computes its width
2. Iterate over children
    - place child renderer (x,y)
    - call child layout if dirty
3. Parent computes its height
4. Parent sets dirty bit to false

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

WHAT TRIGGERS REFLOW?

font size change

user input

screen resize

:hover

add/remove stylesheets

changing class attr

js changing dom

offset calcs

Sheet #1218 of 9189. Patent #2398123
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http://www.stubbornella.org/content/2009/03/27/reflows-repaints-css-performance-making-your-javascript-slow/

BEST PRACTICES

make changes "low" in DOM

avoid inline styles

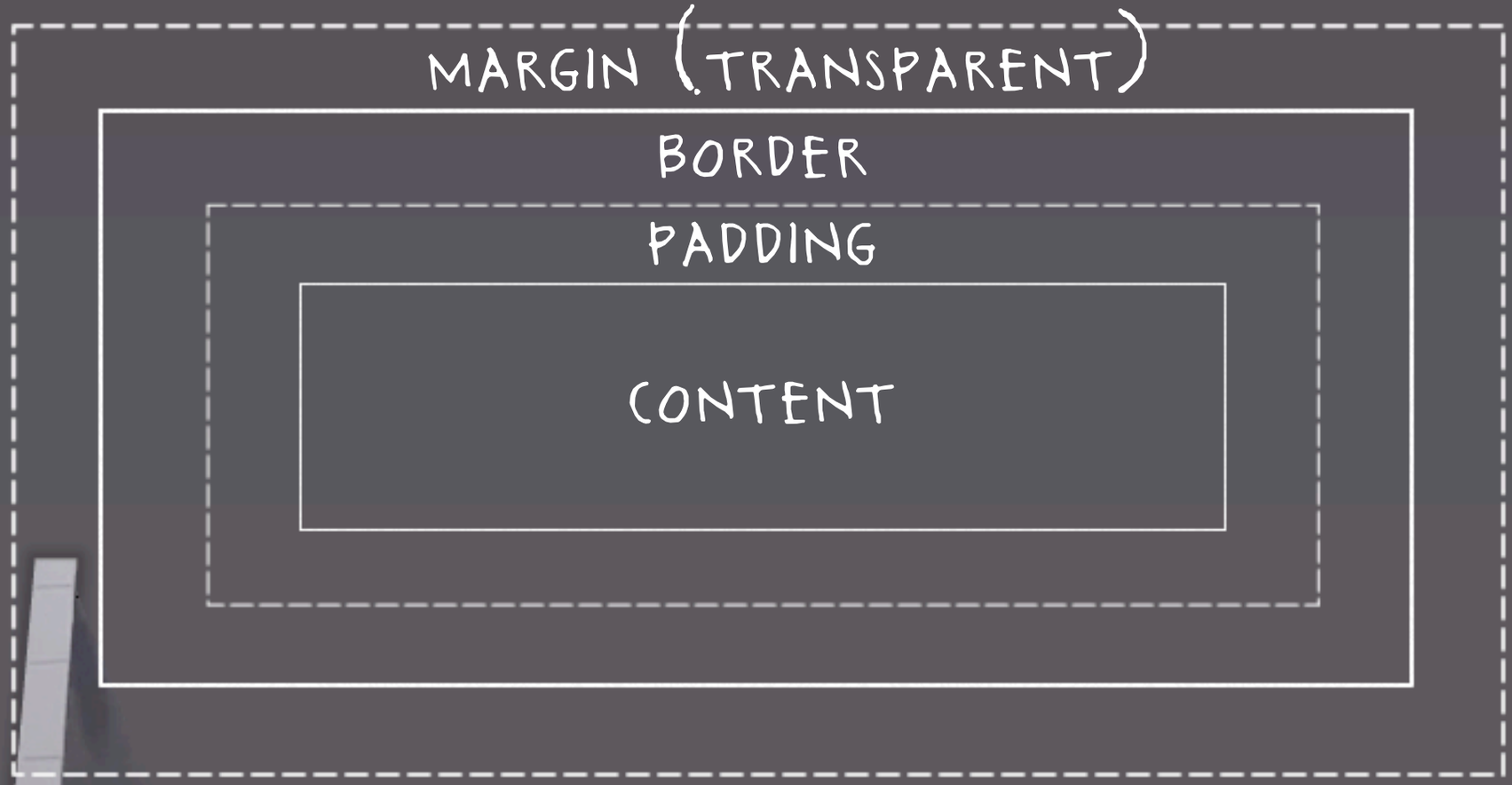
animate fixed/ absolute els

avoid tables for layout

@STUBORNELLA

http://bit.ly/css-js-perf

THE BOX MODEL



3 BOX DISPLAY TYPES

block

inline

none

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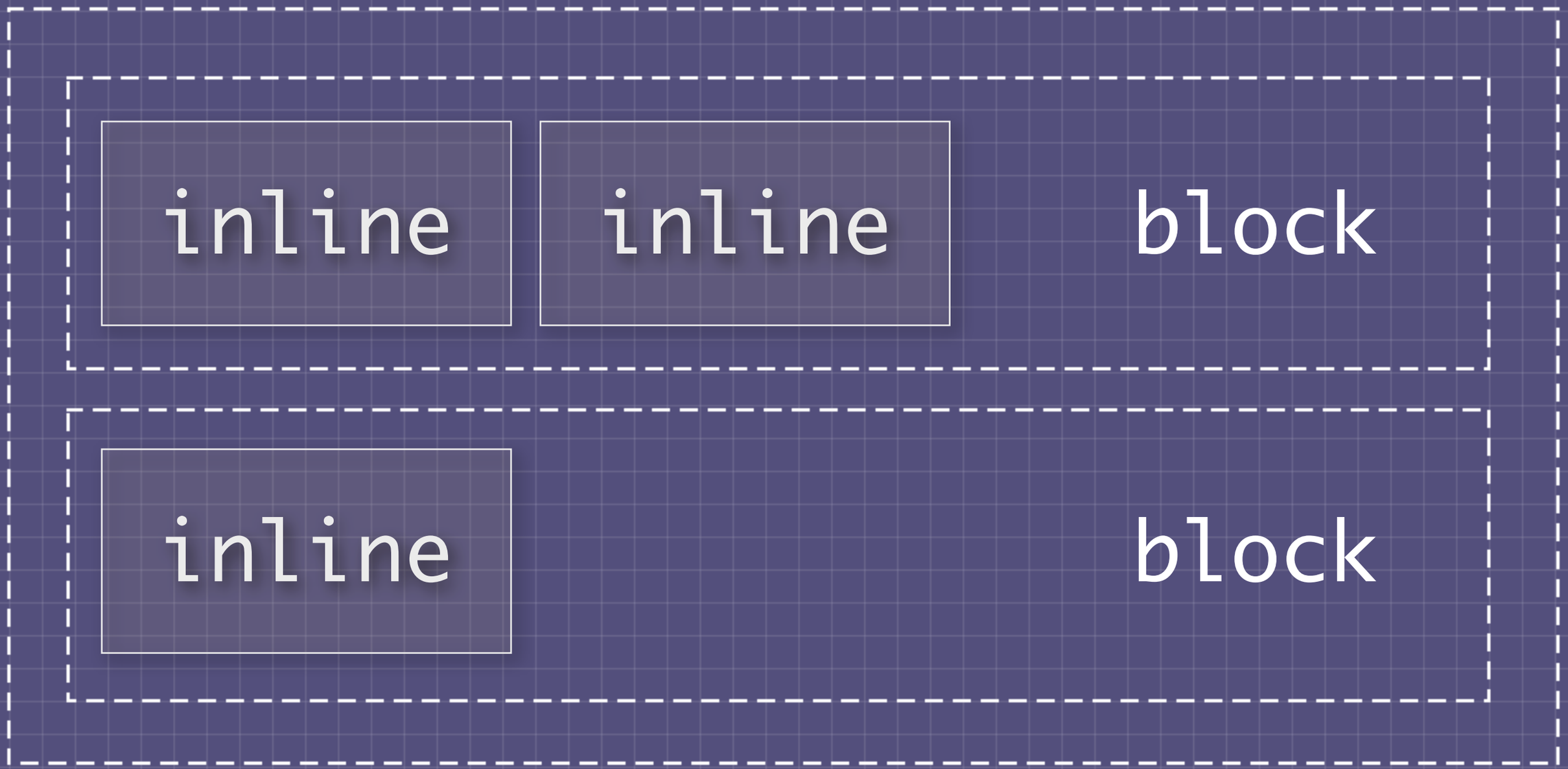
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

HOW BOXES APPEAR



Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

3 POSITIONING SCHEMES

normal

```
position: static;
position: relative;
```

float

```
float: left;
float: right;
```

absolute

```
position: absolute;
position: fixed;
```

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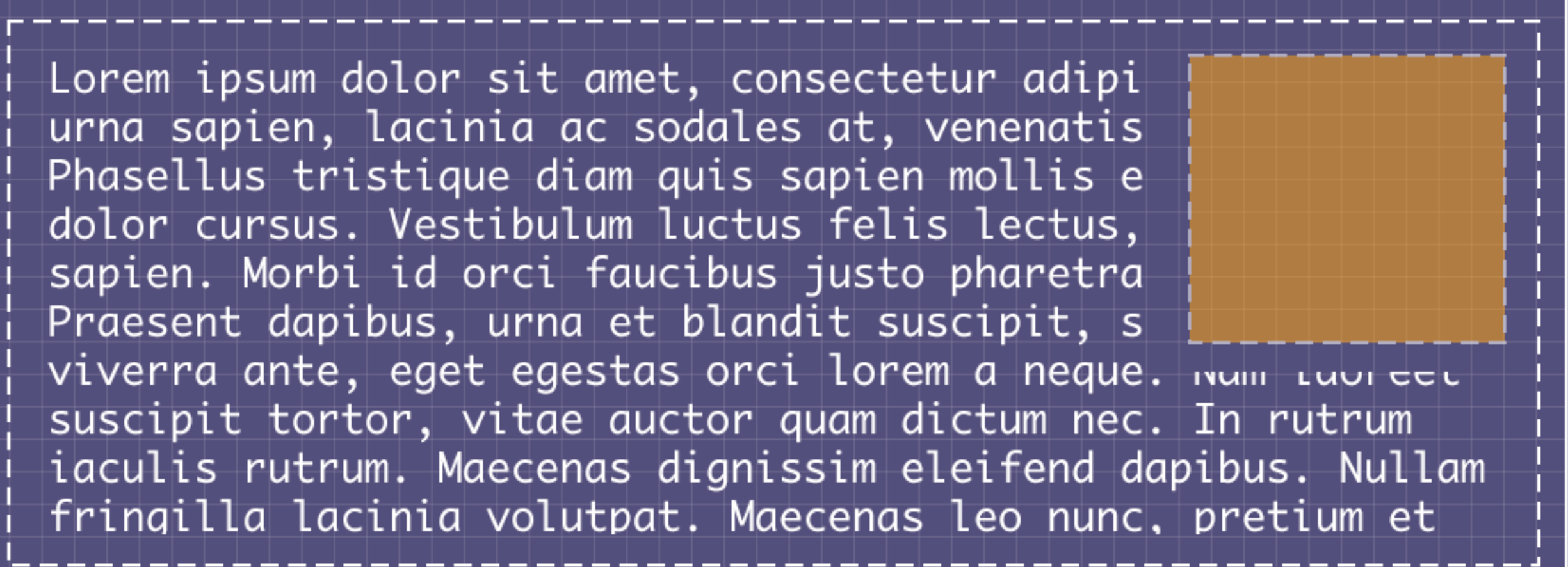
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

FLOAT: LEFT, RIGHT;

```
<html>
  <p>
    <img style='float: right;' width='100' height='100' />
    Lorem ipsum dolor sit amet, conseceteur...
  </p>
</html>
```

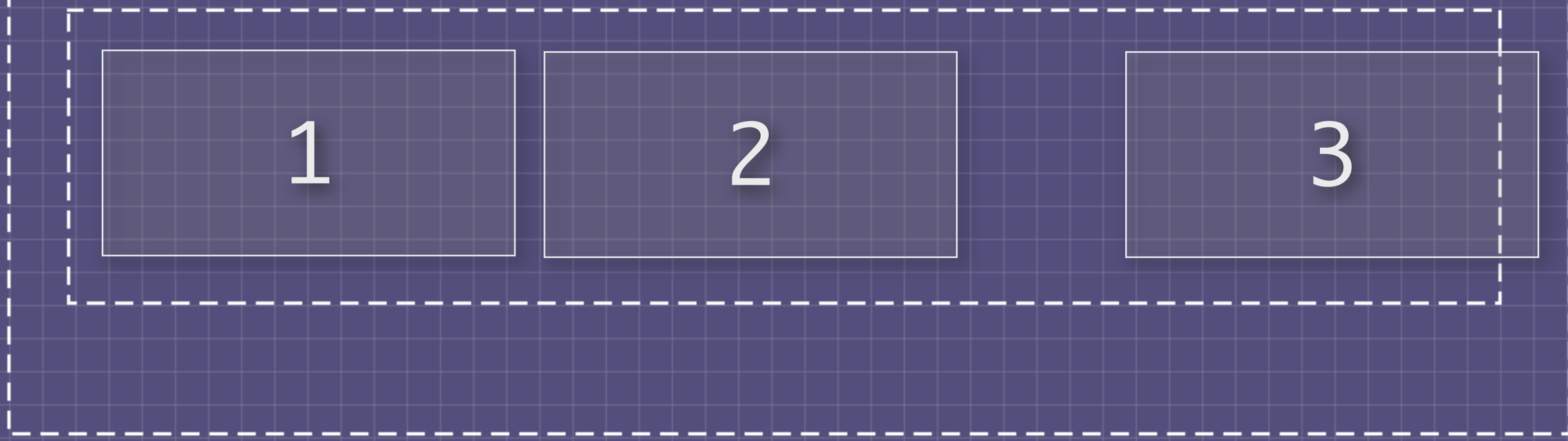


Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

POSITION: RELATIVE;

```
<html>
  <div>
    <span>1</span>
    <span>2</span>
    <span style='position: relative; left: 5px;'>3</span>
  </div>
</html>
```



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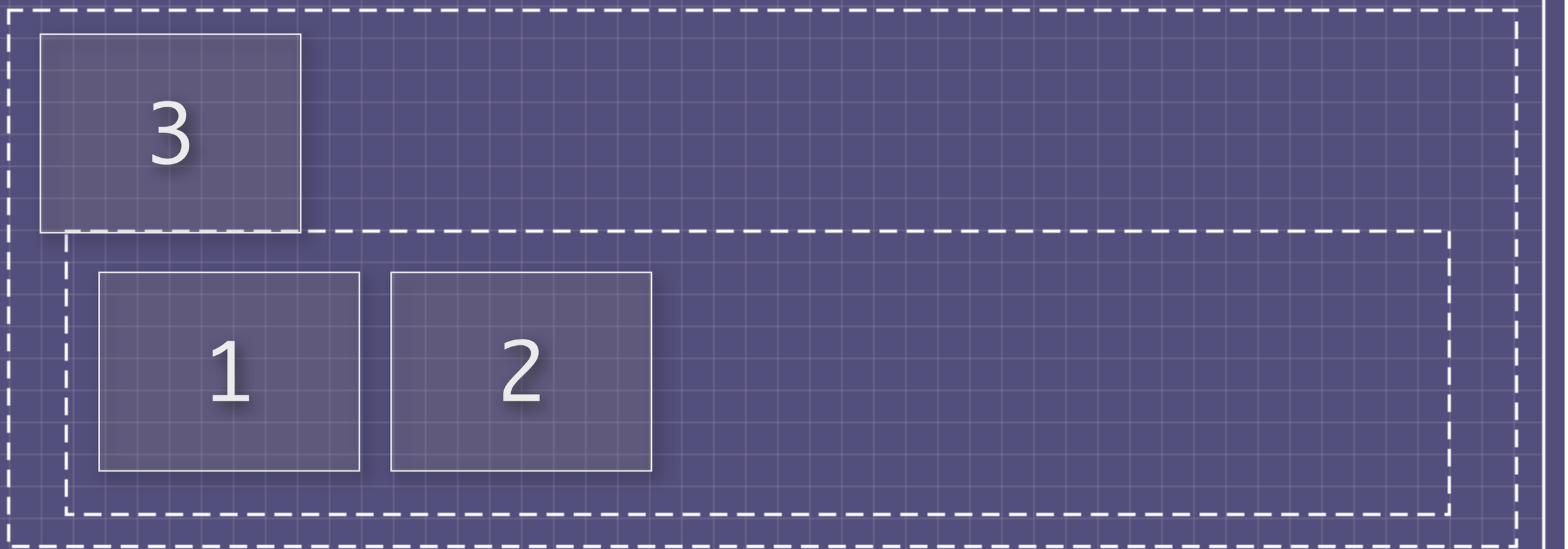
http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

POSITION: ABSOLUTE/FIXED;

```
<html>
  <div>
    <span>1</span>
    <span>2</span>
    <span style='position: absolute; top: 5px; left: 5px;'>3</span>
  </div>
</html>
```



Sheet #1218 of 9189. Patent #2398123
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http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

THE PAINTING PROCESS

1. background color
2. background image
3. border
4. children
5. outline

STACKING CONTEXT

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Painting

I OPTIMIZE PAINTING BY NOT ADDING ELEMENTS THAT WILL BE HIDDEN BENEATH OTHER ELEMENTS ON REPAINT.

I OPTIMIZE PAINTING BY SAVING RECTANGLES IN A BITMAP AND ONLY PAINT DELTAS BETWEEN NEW AND OLD RECTANGLES ON REPAINT.

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Painting

MAIN FLOW:

Parse HTML → DOM Tree → Render Tree → Layout & Paint

Sheet #1218 of 9189. Patent #2398123

http://www.html5rocks.com/en/tutorials/internals/howbrowserswork/#Layout

SOURCES

bitly.com/dmosher/bundles

@dmosher