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# More Digitization

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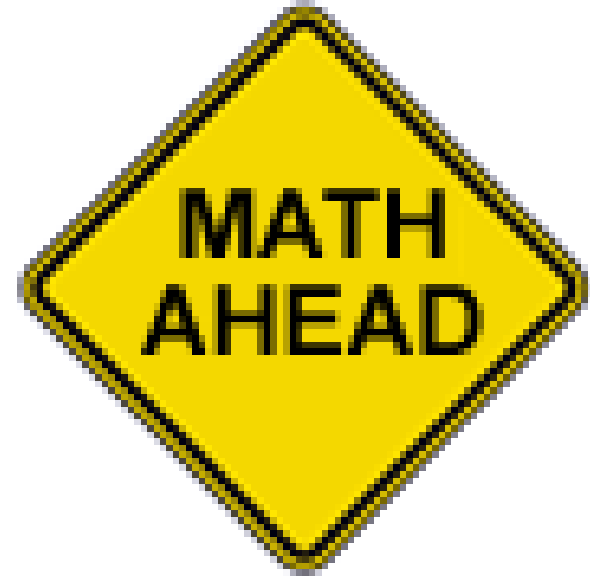
*Light, Sound, Magic:  
Representing Multimedia  
Digitally*

© Lawrence Snyder, 2008

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# Binary to Decimal Conversion

1. Watch the videos
2. Example: Binary to Digital
3. Exercise
4. Example: Digital to Binary
5. Exercise



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# 1. Video

- **Mastering Binary Numbers (9 min.)**  
<http://www.youtube.com/watch?v=CzUjicheqwM&NR=1>
- **Binary in 60 Seconds (1 min.):**  
<http://www.youtube.com/watch?v=qdFmSIFojlw>

## 2. Practice

**IP Address: 10101010.00110100.11100110.00010111**

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>								

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

**First octet: 10101010**

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>								

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

First octet: 10101010

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>	128							

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

First octet: 10101010

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>	128		32					

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

First octet: 10101010

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>	128		32		8			

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

**First octet: 10101010**

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>	128		32		8		2	

# Place Value in a Binary Number

IP Address: 10101010.00110100.11100110.00010111

First octet: 10101010

<b>Power of 2</b>	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Binary</b>	1	0	1	0	1	0	1	0
<b>Decimal</b>	128		32		8		2	

$$128 + 32 + 8 + 2 = 170$$

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# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

Digital								
Value	128	64	32	16	8	4	2	1
Remainder								
Binary								

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255							
<b>Value</b>	128	64	32	16	8	4	2	1
<b>Remainder</b>								
<b>Binary</b>								

---

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255							
<b>Value</b>	-128	64	32	16	8	4	2	1
<b>Remainder</b>								
<b>Binary</b>								

---

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255							
<b>Value</b>	-128	64	32	16	8	4	2	1
<b>Remainder</b>	127							
<b>Binary</b>								

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127						
<b>Value</b>	-128	64	32	16	8	4	2	1
<b>Remainder</b>	127							
<b>Binary</b>	1							

---

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127						
<b>Value</b>	-128	-64	32	16	8	4	2	1
<b>Remainder</b>	127							
<b>Binary</b>	1							

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127						
<b>Value</b>	-128	-64	32	16	8	4	2	1
<b>Remainder</b>	127	63						
<b>Binary</b>	1							

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127						
<b>Value</b>	-128	-64	32	16	8	4	2	1
<b>Remainder</b>	127	63						
<b>Binary</b>	1	1						

# Decimal to Binary Conversion

- Convert this IP address to binary:  
**255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	<b>63</b>					
<b>Value</b>	-128	-64	<b>32</b>	16	8	4	2	1
<b>Remainder</b>	127	<b>63</b>						
<b>Binary</b>	1	1						

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	<b>63</b>					
<b>Value</b>	-128	-64	<b>-32</b>	16	8	4	2	1
<b>Remainder</b>	127	63						
<b>Binary</b>	1	1						

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# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	<b>63</b>					
<b>Value</b>	-128	-64	<b>-32</b>	16	8	4	2	1
<b>Remainder</b>	127	63	<b>31</b>					
<b>Binary</b>	1	1	<b>1</b>					

# Decimal to Binary Conversion

- Convert this IP address to binary:  
**255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	<b>31</b>				
<b>Value</b>	-128	-64	-32	16	8	4	2	1
<b>Remainder</b>	127	63	<b>31</b>					
<b>Binary</b>	1	1	1					

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	<b>31</b>				
<b>Value</b>	-128	-64	-32	<b>-16</b>	8	4	2	1
<b>Remainder</b>	127	63	31					
<b>Binary</b>	1	1	1					

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	<b>31</b>				
<b>Value</b>	-128	-64	-32	<b>-16</b>	8	4	2	1
<b>Remainder</b>	127	63	31	<b>15</b>				
<b>Binary</b>	1	1	1					

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	<b>31</b>				
<b>Value</b>	-128	-64	-32	<b>-16</b>	8	4	2	1
<b>Remainder</b>	127	63	31	<b>15</b>				
<b>Binary</b>	1	1	1	<b>1</b>				

# Decimal to Binary Conversion

- Convert this IP address to binary:  
**255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	<b>15</b>			
<b>Value</b>	-128	-64	-32	-16	8	4	2	1
<b>Remainder</b>	127	63	31	<b>15</b>				
<b>Binary</b>	1	1	1	1				

---

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	<b>15</b>			
<b>Value</b>	-128	-64	-32	-16	<b>-8</b>	4	2	1
<b>Remainder</b>	127	63	31	15				
<b>Binary</b>	1	1	1	1				

# Decimal to Binary Conversion


- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	15			
<b>Value</b>	-128	-64	-32	-16	-8	4	2	1
<b>Remainder</b>	127	63	31	15	7			
<b>Binary</b>	1	1	1	1	1			

# Decimal to Binary Conversion

- Convert this IP address to binary:  
**255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	15	7		
<b>Value</b>	-128	-64	-32	-16	-8	4	2	1
<b>Remainder</b>	127	63	31	15	7			
<b>Binary</b>	1	1	1	1	1			



# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	15	7		
<b>Value</b>	-128	-64	-32	-16	-8	-4	2	1
<b>Remainder</b>	127	63	31	15	7			
<b>Binary</b>	1	1	1	1	1			

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7		
<b>Value</b>	-128	-64	-32	-16	-8	-4	2	1
<b>Remainder</b>	127	63	31	15	7	3		
<b>Binary</b>	1	1	1	1	1			

# Decimal to Binary Conversion

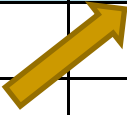
- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7		
<b>Value</b>	-128	-64	-32	-16	-8	-4	2	1
<b>Remainder</b>	127	63	31	15	7	3		
<b>Binary</b>	1	1	1	1	1	1		

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	<b>3</b>	
<b>Value</b>	-128	-64	-32	-16	-8	-4	2	1
<b>Remainder</b>	127	63	31	15	7	<b>3</b>		
<b>Binary</b>	1	1	1	1	1	1		



# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	3	
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	1
<b>Remainder</b>	127	63	31	15	7	3		
<b>Binary</b>	1	1	1	1	1	1		

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	3	
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	1
<b>Remainder</b>	127	63	31	15	7	3	1	
<b>Binary</b>	1	1	1	1	1	1		

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# Decimal to Binary Conversion


- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	3	
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	1
<b>Remainder</b>	127	63	31	15	7	3	1	
<b>Binary</b>	1	1	1	1	1	1	1	

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	15	7	3	<b>1</b>
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	1
<b>Remainder</b>	127	63	31	15	7	3	<b>1</b>	
<b>Binary</b>	1	1	1	1	1	1	1	



# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- First, second, and third octets: 255

<b>Digital</b>	255	127	63	31	15	7	3	<b>1</b>
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	<b>-1</b>
<b>Remainder</b>	127	63	31	15	7	3	1	
<b>Binary</b>	1	1	1	1	1	1	1	

---

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	3	<b>1</b>
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	<b>-1</b>
<b>Remainder</b>	127	63	31	15	7	3	1	<b>0</b>
<b>Binary</b>	1	1	1	1	1	1	1	

# Decimal to Binary Conversion

- **Convert this IP address to binary:  
255.255.255.0**
- **First, second, and third octets: 255**

<b>Digital</b>	255	127	63	31	15	7	3	<b>1</b>
<b>Value</b>	-128	-64	-32	-16	-8	-4	-2	<b>-1</b>
<b>Remainder</b>	127	63	31	15	7	3	1	<b>0</b>
<b>Binary</b>	1	1	1	1	1	1	1	<b>1</b>

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# Digital to Binary Exercises

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# Exercise


# Changing Decimal Numbers to Binary Numbers

- If the number being converted is smaller than the place value below it, copy the number into the next cell to its right; enter 0 as the binary digit.
- If the number being converted is equal to or larger than the place value below it, subtract the place value from the number and copy the result into the first cell of the next column; enter a 1 as the binary digit.

Number being converted	200									
Place value	512	256	128	64	32	16	8	4	2	1
<i>Subtract</i>										
Binary Number										



# Summary

0000 0000 | 1111 0001 | 0000 1000 | 0010 0000 = 15,796,256 interpreted as a binary number  
=  interpreted as an RGB(241,8,32) color (last 3 bytes)  
= ADD 1,7,17 interpreted as a MIPS machine instruction  
= N U S ñ ð interpreted as 8-bit ASCII—null, backspace, n-tilde, blank  
= L: +241, R: +280 interpreted as sound samples  
= 0.241.8.32 interpreted as an IP address  
= 00 F1 08 20 interpreted as a hexadecimal number

**Figure 11.8.** Illustration of the principle that “bits are bits.” The same 4 bytes shown can be interpreted differently.