

# CDMA, Wireless And Watermarking

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ICANN 43 San Jose, Costa Rica

Tech Day

12 /March /2012

# WATERMARKS



**Visible**



**Invisible**

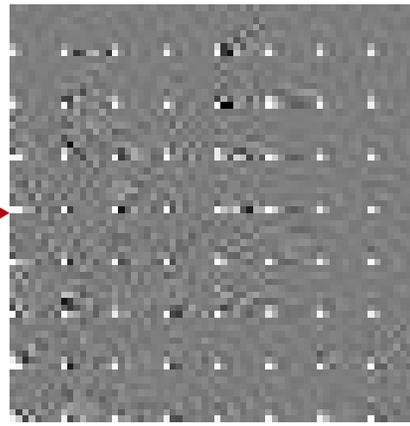
# WATERMARKING APPLICATIONS

- **Content identification and management**
- **Content protection for audio and video content**
- **Forensics and piracy deterrence**
- **Content filtering (includes blocking and triggering of actions)**
- **Communication of ownership and copyrights**
- **Document and image security**
- **Authentication of content and objects**
- **Broadcast monitoring**
- **Locating content online**
- **Rich media enhancement for mobile phones**
- **Audience measurement**
- **Fingerprinting/Audit Trail/Traitor Tracing**

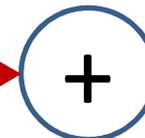
# WATERMARK EMBEDDING



DATA FILE = IMAGE



TRANSFORMED IMAGE



WATERMARKED IMAGE

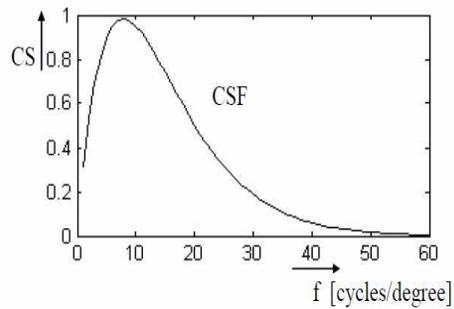
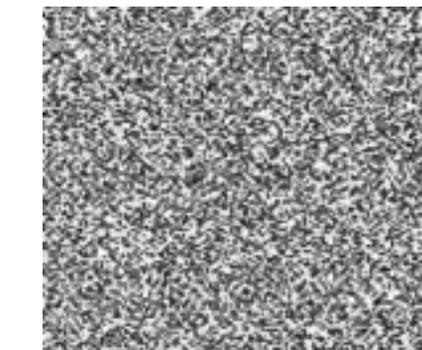


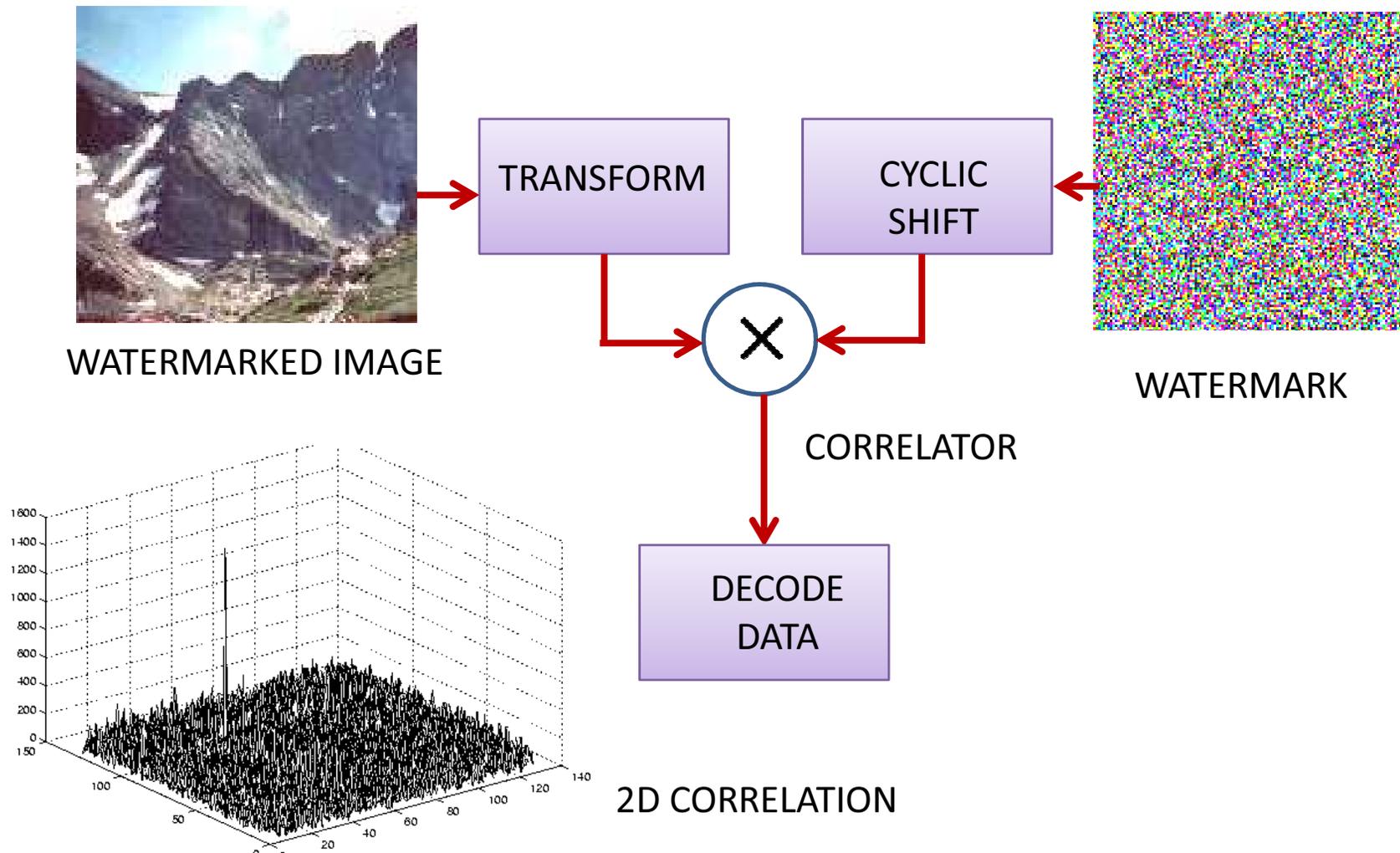
Fig. 1. Contrast Sensitivity Function.

Human Visual System Models in Digital Image Watermarking



WATERMARK  
(CONTAINS HIDDEN DATA)  
MODIFIED BY HVS

# WATERMARK EXTRACTION

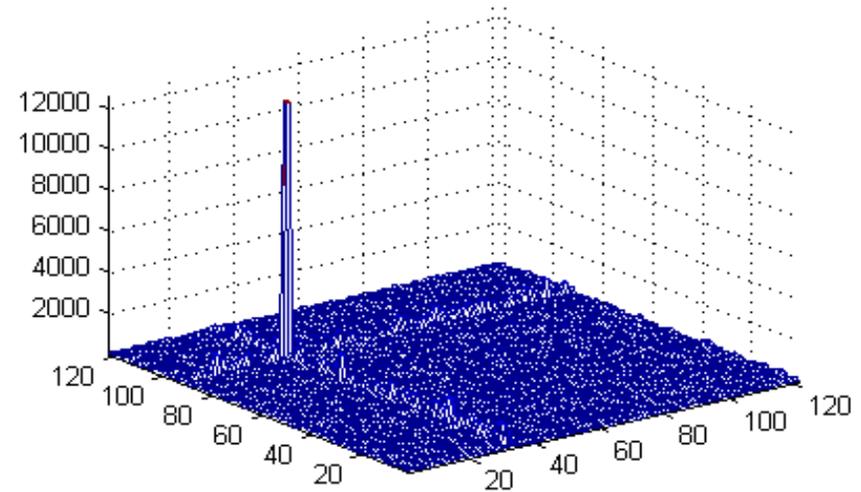


# An Example



D

128x128 JPEG



**WATERMARK DETECTION USING  
CORRELATION**



$D_w$

**WATERMARK WAS APPLIED  
WITH ENOUGH POWER TO  
MAKE IT JUST VISIBLE**

# HIGH CAPACITY WATERMARKS

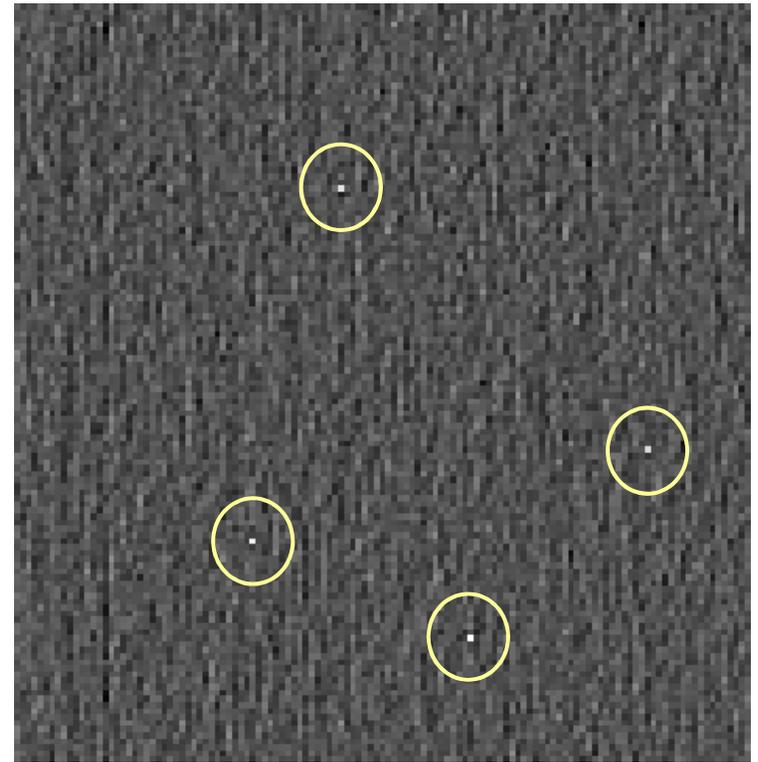


**Original  
127x127x8 bit**



**127x127 binary  
watermarks added  
in spatial domain**

**OUR ARRAYS HAVE LOW CROSS-CORRELATION.  
HERE, 4 ARRAYS ARE EMBEDDED IN AND  
EXTRACTED FROM THE SAME IMAGE.  
THIS INCREASES DATA CAPACITY 4 TIMES!!!**



**Filtered Correlation Output showing  
the location of 4 peaks for  $m = 1$**

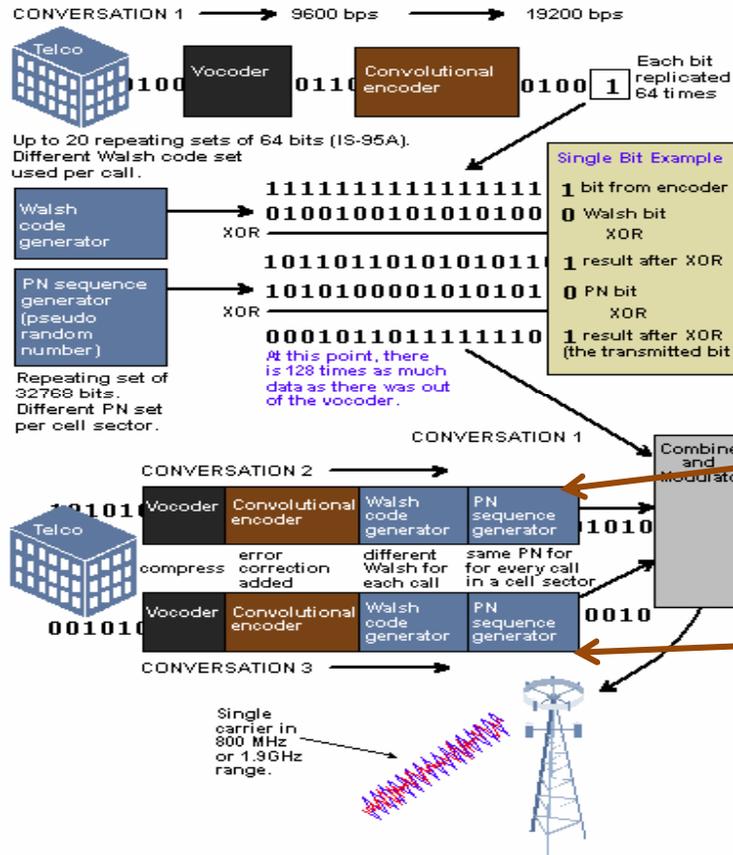
# A UNIQUE WATERMARK FOR EVERY IMAGE?



- OUR ARRAYS ARE GENERATED ALGEBRAICALLY AND ARE ALL DISTINCT
- WE CAN GENERATE AT LEAST ONE ARRAY FOR EVERY IMAGE WHICH CURRENTLY EXISTS
- SUCH ARRAYS CAN BE EMBEDDED USING A SIMM CARD OR AN FPGA IN THE CAMERA
- WATERMARKS CREATED BY RANDOM NUMBER CANNOT GUARANTEE UNIQUENESS

# CDMA TRANSMITTER

## Transmitting CDMA Conversations From the Base Station

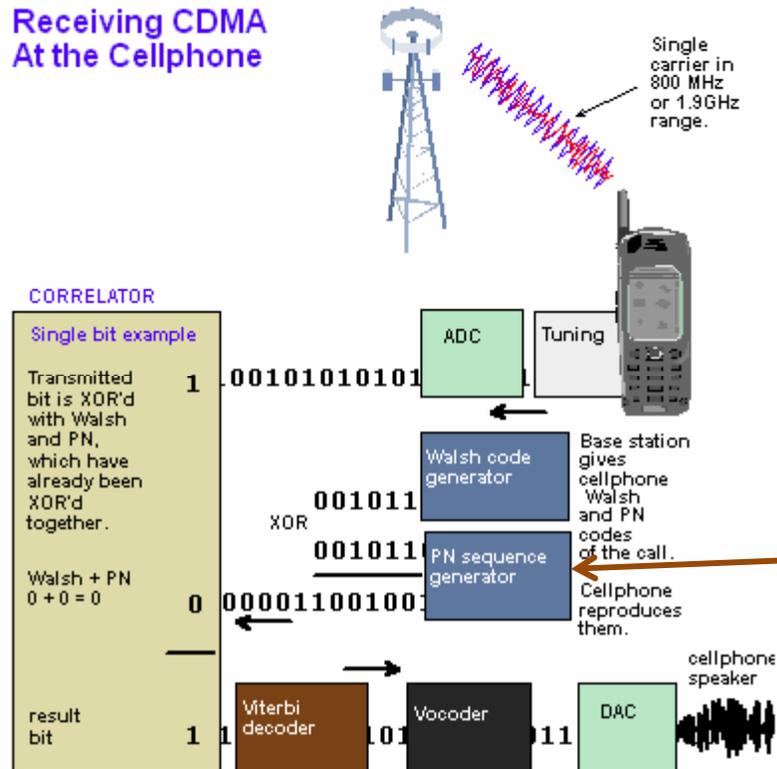


**A KEY COMPONENT OF CDMA IS THE PN SEQUENCE GENERATOR:**

**OUR SEQUENCES ARE MORE SECURE, AND BALANCED THAN CONVENTIONAL ONES**

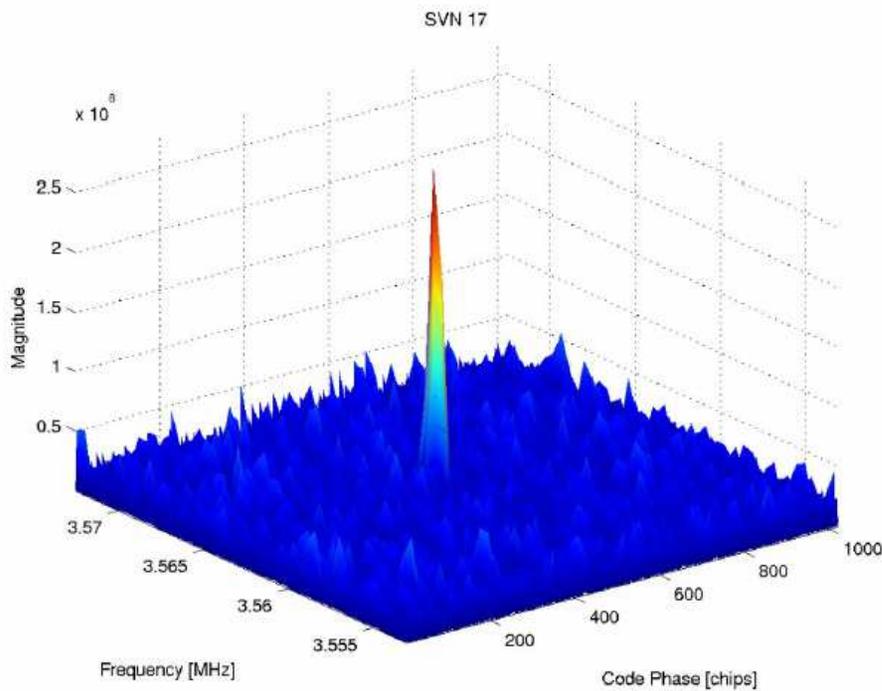
# CDMA RECEIVER

Receiving CDMA  
At the Cellphone



**THE PROCESS OF EMBEDDING AND EXTRACTION OF A PN SEQUENCE IS A ONE DIMENSIONAL VERSION OF OUR WATERMARK EMBEDDING AND EXTRACTION SCHEME**

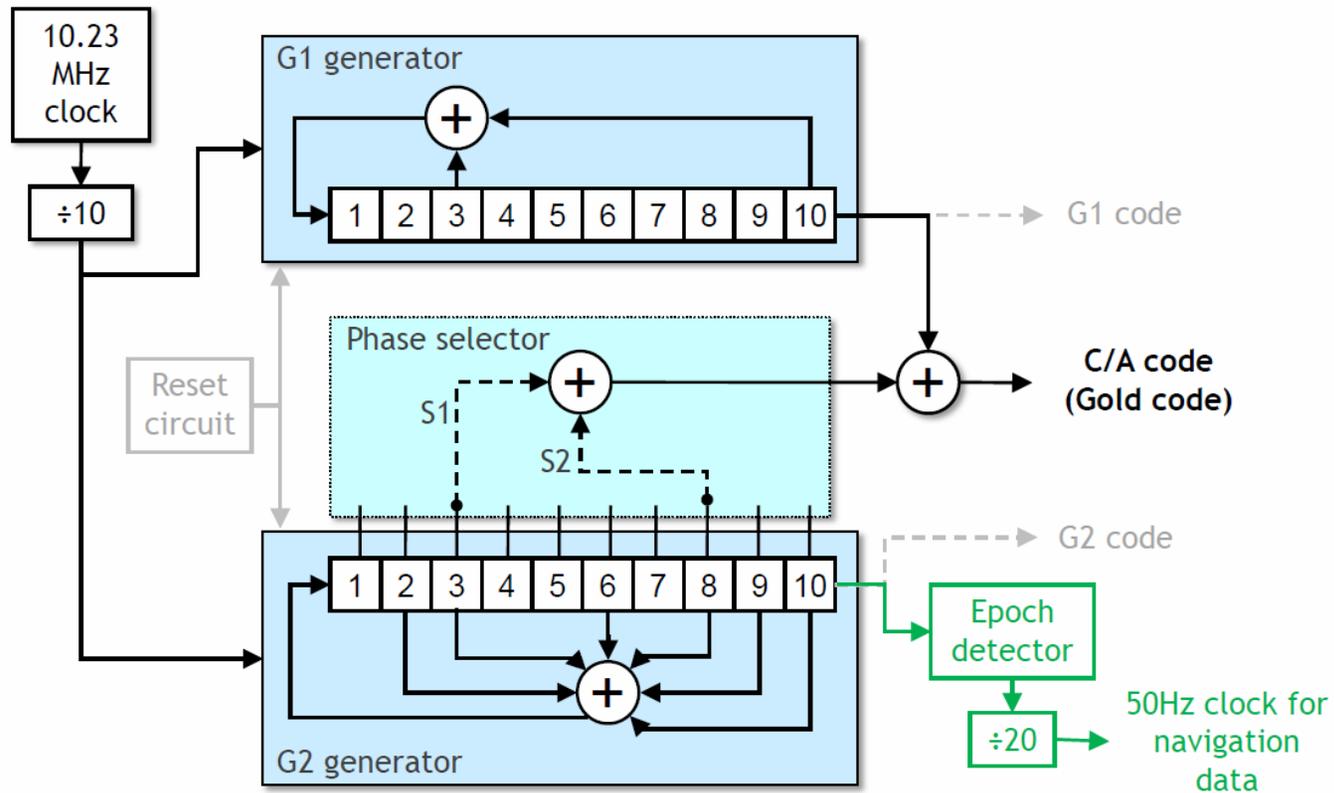
# GPS PRINCIPLE



**CORRELATION PEAK  
BETWEEN CODE PHASE  
AND CARRIER  
FREQUENCY YIELDS TIME  
AND POSITION  
INFORMATION FROM  
THE RECEIVED GNSS  
SIGNAL**

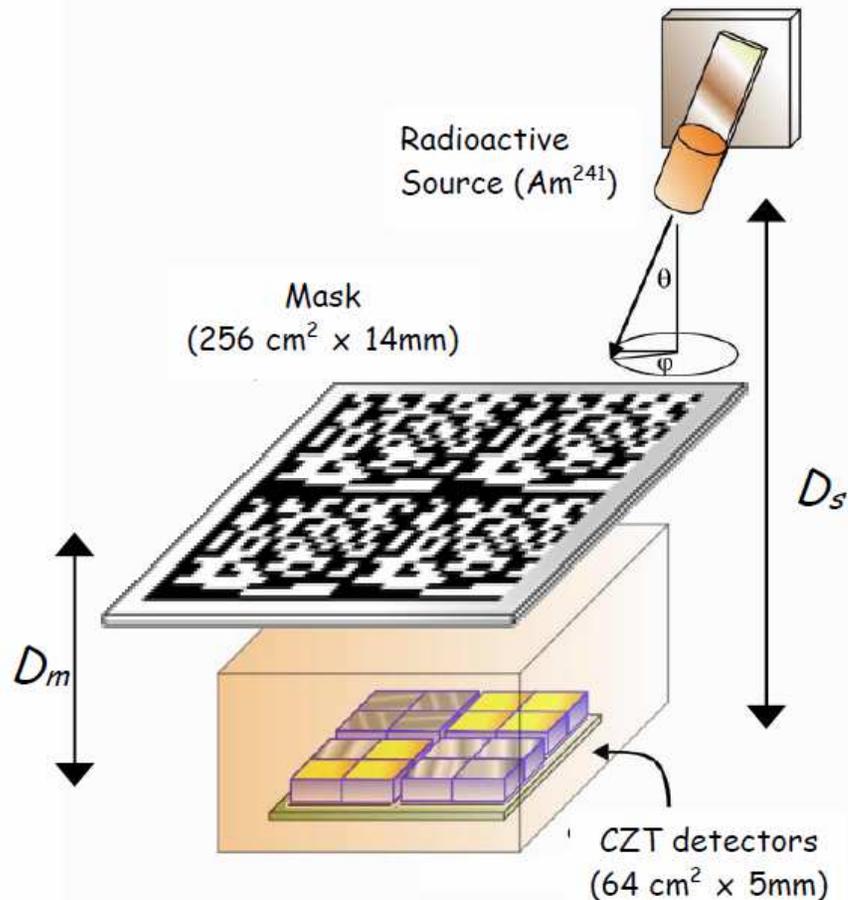
# GPS SHORT CODE

The C/A (COARSE ACQUISITION) code is a 1,023 bit GOLD CODE which, when transmitted at 1.023 Megabits per second, repeats every millisecond.



**OUR CONSTRUCTION PRODUCES NEW AND SUPERIOR SEQUENCES**

# CODED APERTURE IMAGING



SHADOW OF MASK IS CORRELATED WITH APERTURE PATTERN. DISPLACEMENT OF AUTOCORRELATION PEAK DETERMINES  $\theta$  AND  $\phi$



METAL MASK

**OUR PATENTED TWO-DIMENSIONAL LEGENDRE ARRAY CAN BE USED TO CONSTRUCT CODED APERTURE MASKS THAT ENABLE IMAGING OF X RAYS AND GAMMA RAYS, WHERE NO LENSES EXIST**

# WATERMARK CONSTRUCTION

- CONVENTIONAL

USE A DIGITAL OR ANALOG RANDOM NUMBER GENERATOR

SIMPLE, BUT CANNOT GUARANTEE UNAMBIGUOUS DETECT

- OUR METHOD

USE A FAMILY OF ARRAYS WITH GOOD AUTO AND CROSS-CORRELATION

REQUIRES FINITE FIELD THEORY, AND CAN GUARANTEE UNAMBIGUOUS DETECT

# ARRAY FAMILIES FOR FINGERPRINTING

- Large array size

So that correlation peak is larger than cross-correlation with image

- Large peak auto-correlation

So that correlation peak is largest at the correct cyclic shift

- Low off-peak auto-correlation

So that correlation values for other shifts are smaller

- Low cross-correlation

So that it is not possible to confuse one fingerprint with another

- Large family size

So that a large number of recipients can be accommodated

- Balance

So that watermarked image has the same mean value as the original so watermark is imperceptible

**NOTE: WE USE MULTI-PERIODIC CORRELATIONS**

# CONSTRUCTION METHOD

WE USE A COMPOSITION OF TWO  
SEQUENCES/ARRAYS

1. A MULTI-PERIODIC SHIFT SEQUENCE/ARRAY
2. A COMMENSURATE MULTI-PERIODIC  
COLUMN SEQUENCE/ARRAY

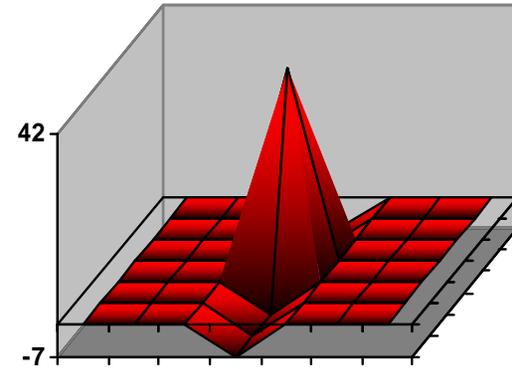
**BOTH ARE OBTAINED FROM FINITE FIELDS**

# CONSTRUCTION OF ARRAY FAMILY

Shift Sequence

LEGEND →

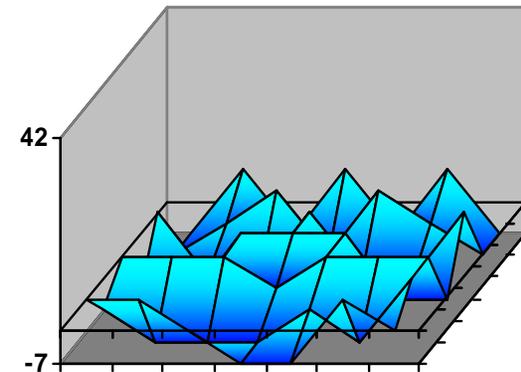
	0	6	4	1	4	6	0
0	1	-1	-1	-1	1	1	0
1	1	1	0	1	1	1	1
1	-1	-1	1	-1	-1	-1	1
-1	1	-1	1	-1	1	-1	-1
1	-1	0	-1	0	-1	1	1
-1	-1	1	1	1	-1	-1	-1
-1	0	1	-1	1	0	-1	-1



Autocorrelation 7x7 Array

Another Array

	0	5	1	2	1	5	0
0	1	-1	-1	-1	1	1	0
1	-1	0	-1	0	-1	1	1
1	1	1	0	1	1	1	1
-1	-1	1	1	1	-1	-1	-1
1	-1	-1	1	-1	-1	-1	1
-1	0	1	-1	1	0	-1	-1
-1	1	-1	1	-1	1	-1	-1



Cross-correlation 7x7 Arrays

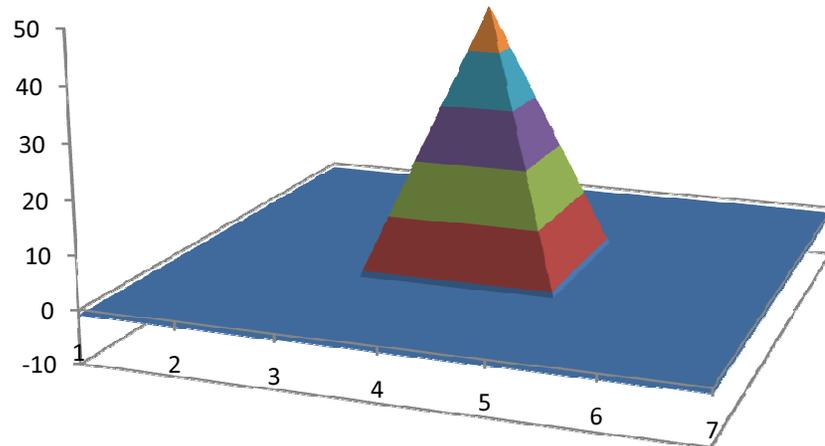
6 such arrays with quadratic shift sequence have the auto and cross-correlation properties as above

# MULTI-DIMENSIONAL LEGENDRE ARRAY

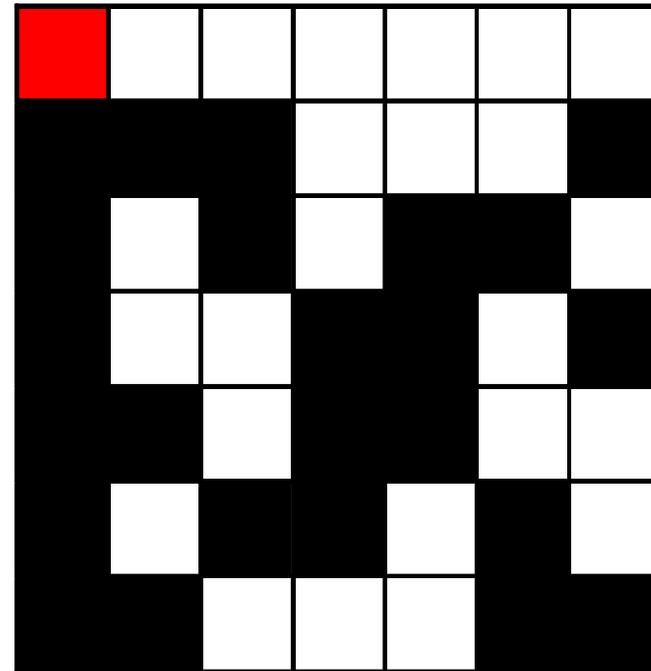
**b**

	0	1	2	3	4	5	6
0	*	0	16	8	32	40	24
1	1	31	11	26	12	14	5
2	17	28	47	30	27	21	42
3	9	22	34	39	13	20	19
4	33	43	44	37	15	10	46
5	41	18	45	3	6	23	4
6	25	29	38	36	2	35	7

$$\alpha^i = b\alpha + c \in GF(p^2)$$



Autocorrelation



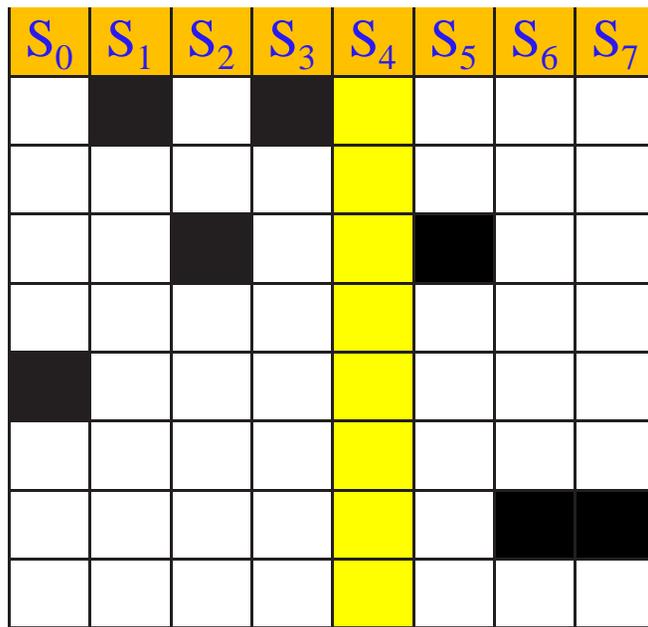
$$c_i = (-1)^{i \bmod 2}$$

# 2D LOG QUADRATIC CONSTRUCTION

SHIFT SEQUENCE

$$s_j = \log_{\alpha}(A\alpha^{2j} + B\alpha^j + C)$$

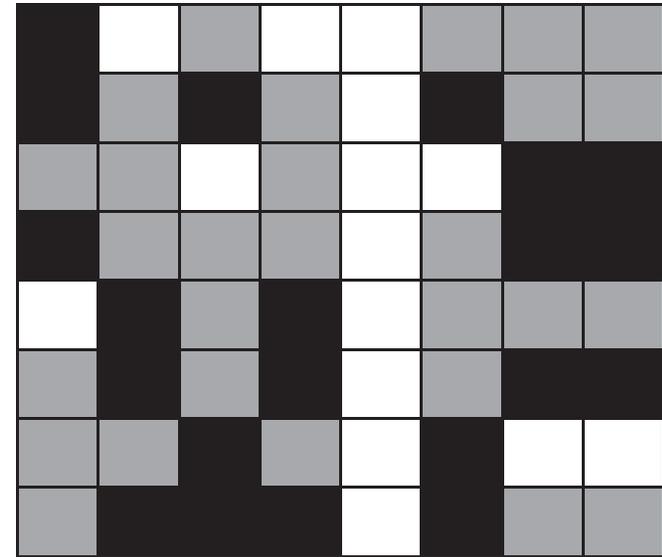
Approximately  $p$  quadratics leading to distinct arrays



COLUMN



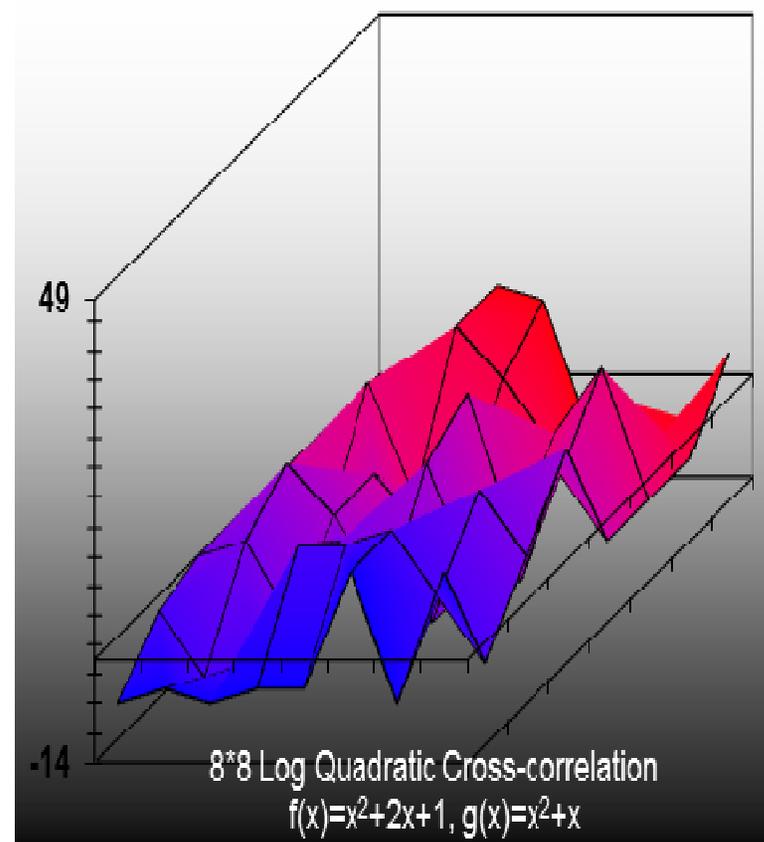
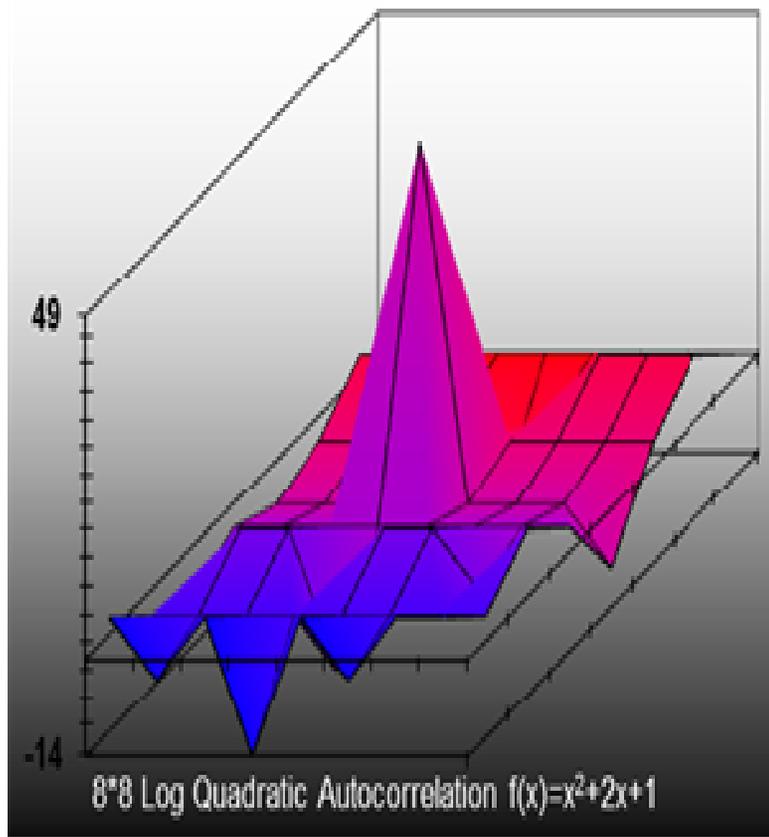
ARRAY



$$c_i = (-1)^{\lfloor \log_{\alpha}(\alpha^i - 1) \rfloor} \bmod 2$$

SIDELNIKOV

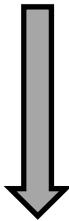
# CORRELATION



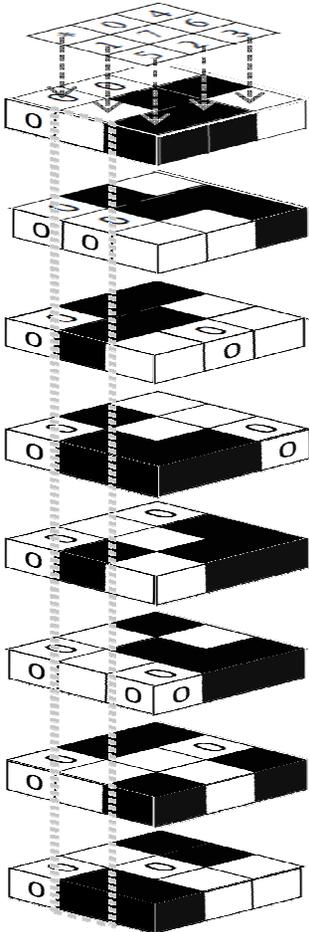
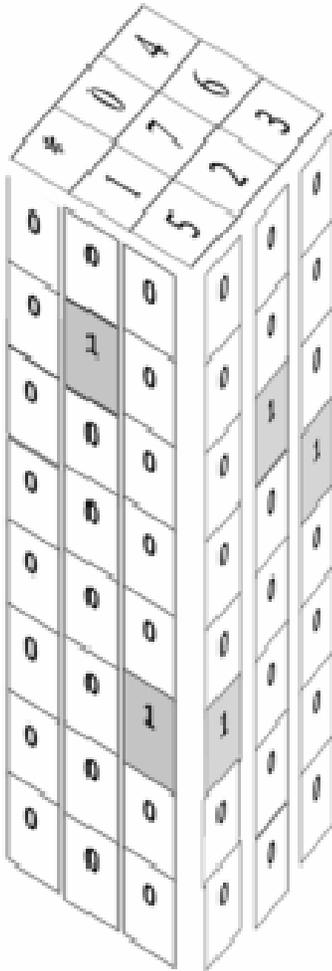
# 3D LOG QUADRATIC CONSTRUCTION

$GF(3^2)$

*	$\alpha^0$	$\alpha^4$
$\alpha^1$	$\alpha^7$	$\alpha^6$
$\alpha^5$	$\alpha^2$	$\alpha^3$

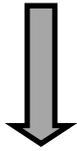


*	0	4
1	7	6
5	2	3



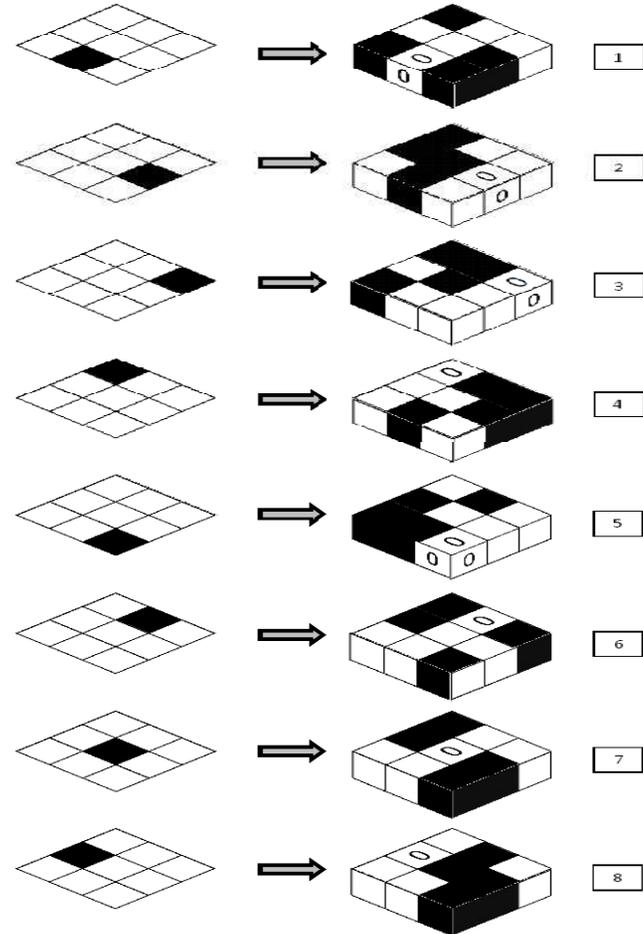
# 3D EXPONENTIAL QUADRATIC CONSTRUCTION

*	$\alpha^8$	$\alpha^4$
$\alpha^1$	$\alpha^7$	$\alpha^6$
$\alpha^5$	$\alpha^2$	$\alpha^3$

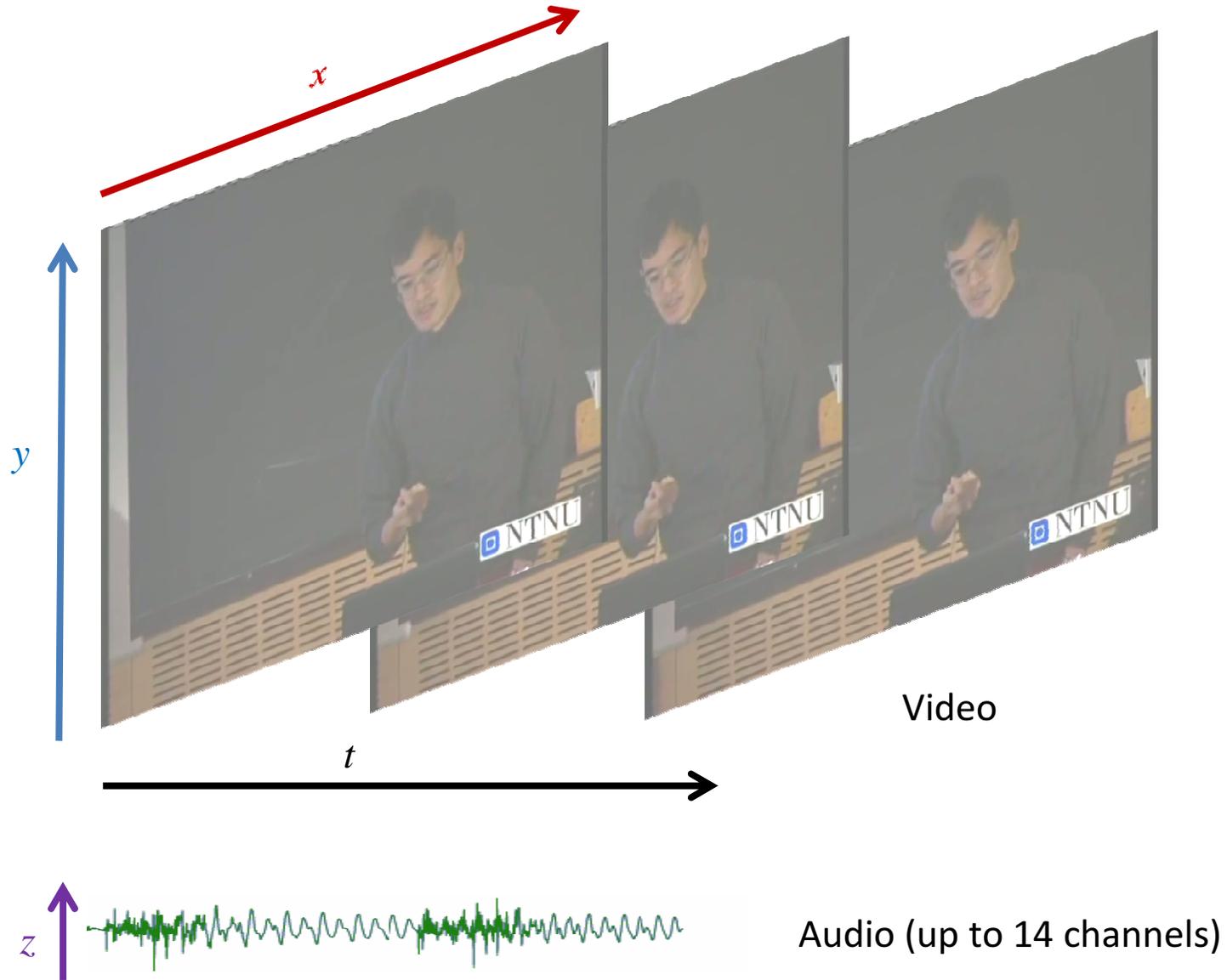


1	(1,0)
2	(2,1)
3	(2,2)
4	(0,2)
5	(2,0)
6	(1,2)
7	(1,1)
8	(0,1)

0		



# MULTI-DIMENSIONAL MULTIMEDIA



# Project 1 – Audio Recording

Emergency



© Can Stock Photo – csp7246516

Hospital



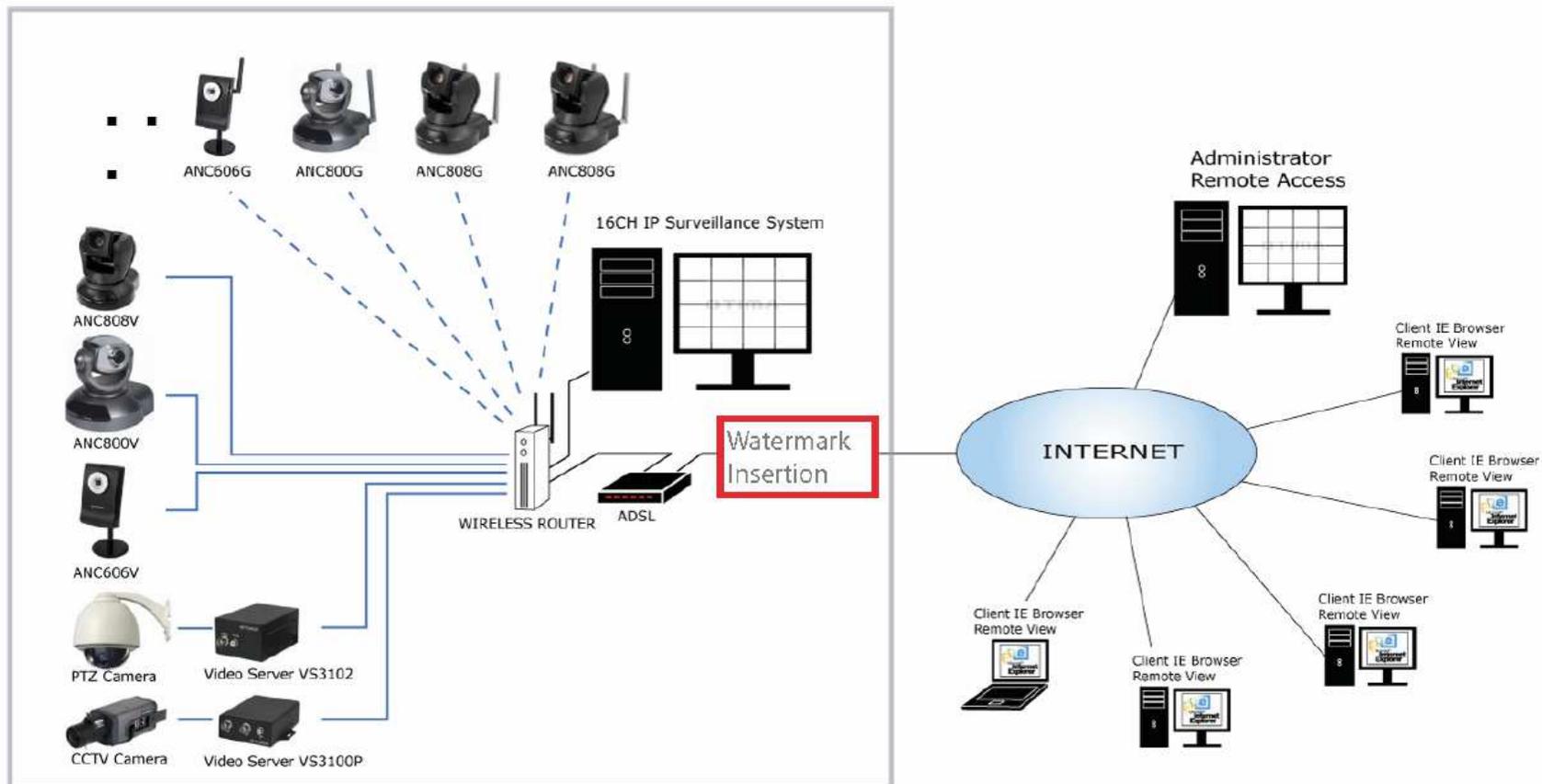
Watermark



Recording Device

Emergency Call + Watermark

# Project 2 - Video Surveillance

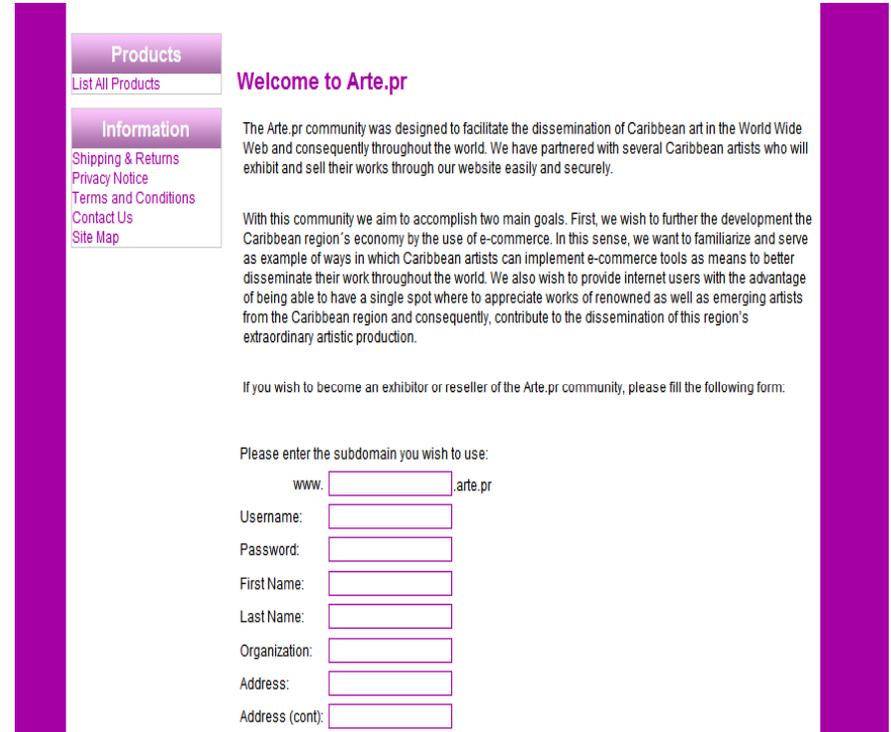


# Project 2



# E-Commerce Communities

- Arte.pr community was designed to facilitate the sale of Caribbean art on the internet. We have partnered with several Caribbean artists who exhibit and sell their works through our website easily and safely.



The screenshot shows a website interface for Arte.pr. On the left is a vertical navigation menu with two main sections: 'Products' and 'Information'. Under 'Products' is a link for 'List All Products'. Under 'Information' are links for 'Shipping & Returns', 'Privacy Notice', 'Terms and Conditions', 'Contact Us', and 'Site Map'. The main content area is titled 'Welcome to Arte.pr' and contains a paragraph of text explaining the community's purpose. Below this is a registration form with the heading 'If you wish to become an exhibitor or reseller of the Arte.pr community, please fill the following form:'. The form includes a prompt 'Please enter the subdomain you wish to use:' followed by a text input field and the suffix '.arte.pr'. Below this are several labeled input fields: 'Username:', 'Password:', 'First Name:', 'Last Name:', 'Organization:', 'Address:', and 'Address (cont):'.

**Products**  
List All Products

**Information**  
Shipping & Returns  
Privacy Notice  
Terms and Conditions  
Contact Us  
Site Map

## Welcome to Arte.pr

The Arte.pr community was designed to facilitate the dissemination of Caribbean art in the World Wide Web and consequently throughout the world. We have partnered with several Caribbean artists who will exhibit and sell their works through our website easily and securely.

With this community we aim to accomplish two main goals. First, we wish to further the development the Caribbean region's economy by the use of e-commerce. In this sense, we want to familiarize and serve as example of ways in which Caribbean artists can implement e-commerce tools as means to better disseminate their work throughout the world. We also wish to provide internet users with the advantage of being able to have a single spot where to appreciate works of renowned as well as emerging artists from the Caribbean region and consequently, contribute to the dissemination of this region's extraordinary artistic production.

If you wish to become an exhibitor or reseller of the Arte.pr community, please fill the following form:

Please enter the subdomain you wish to use:  
www: .arte.pr

Username:

Password:

First Name:

Last Name:

Organization:

Address:

Address (cont):

# User Communities

- We have given the task of designing a user community for the users of .PR, the purpose of the community is seeking to establish a channel with strong links between domain users of the .PR and domain administration, in order to better serve the community and achieve higher levels of excellence.

