RSAConference2019
San Francisco | March 4 – 8 | Moscone Center

SESSION ID: IDY-F03

Are Spoof-Proof Biometrics Really Possible?

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RSAConference2019

Authentication Technology Landscape

Biometric Presentation Attacks
(Methods, Framework)

Next Gen Technology
(The role of liveness in detection)

Benchmarking (Competitions, Datasets)

Standards & Requirements (ISO, platforms)

Certification
(FIDO, Common Criteria)

Before We Begin: Vocabulary

- Presentation Attacks
  - Presentation of an artefact or human characteristic to the biometric capture subsystem in a fashion that could interfere with the intended policy of the biometric system*
  - Spoofs, artefacts, altered biometrics, non-conformance, obfuscation
- Presentation Attack Detection
  - Examples: liveness detection, altered fingerprint detection, anti-spoofing

*ISO/IEC CD 30107-1, Information Technology — Biometrics -- Presentation Attack Detection

THE WORLD HAS A PASSWORD PROBLEM

81%

Data breaches in 2016 that involved **weak, default, or stolen passwords**[1]

65%

Increase in **phishing attacks** over the number of attacks recorded in 2015[2]

1,579

Breaches in 2017, **a 45% increase over 2016**[3]

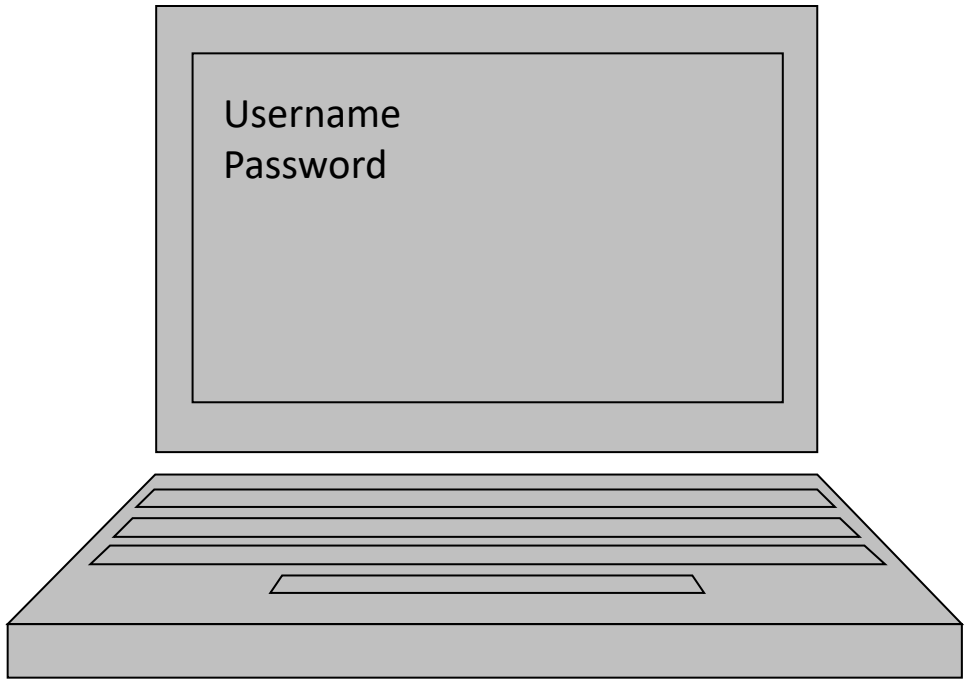
CLUMSY | HARD TO REMEMBER | NEED TO BE CHANGED ALL THE TIME

[1]Verizon 2017 Data Breach Report |[2]Anti-Phishing Working Group | [3]Identity Theft Resource Center 2017

CITeR Center for Identification Technology Research

What Can You Do with a Stolen Password?

1. Find any computing device
2. Type in password

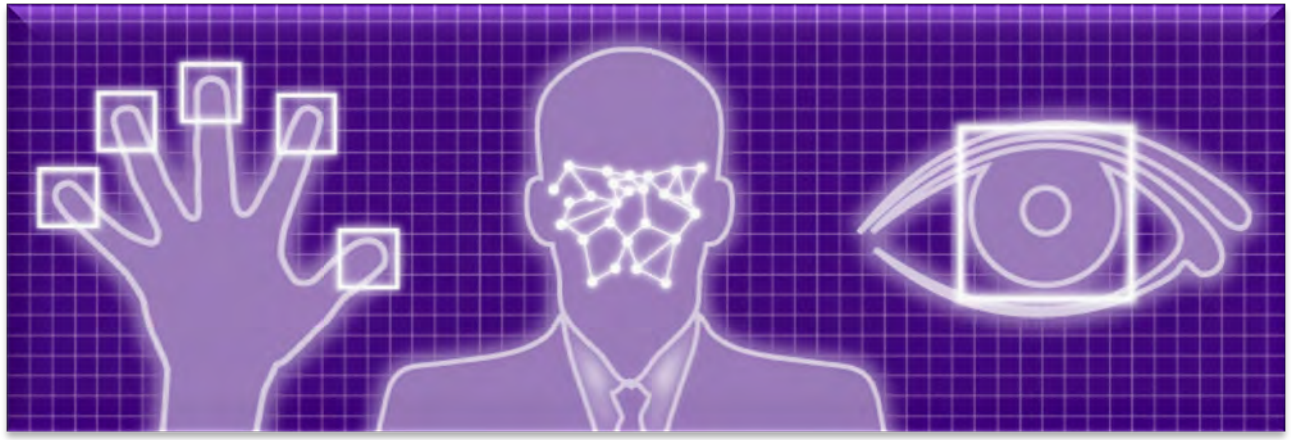


Traditional Username & Password

Easily Scalable

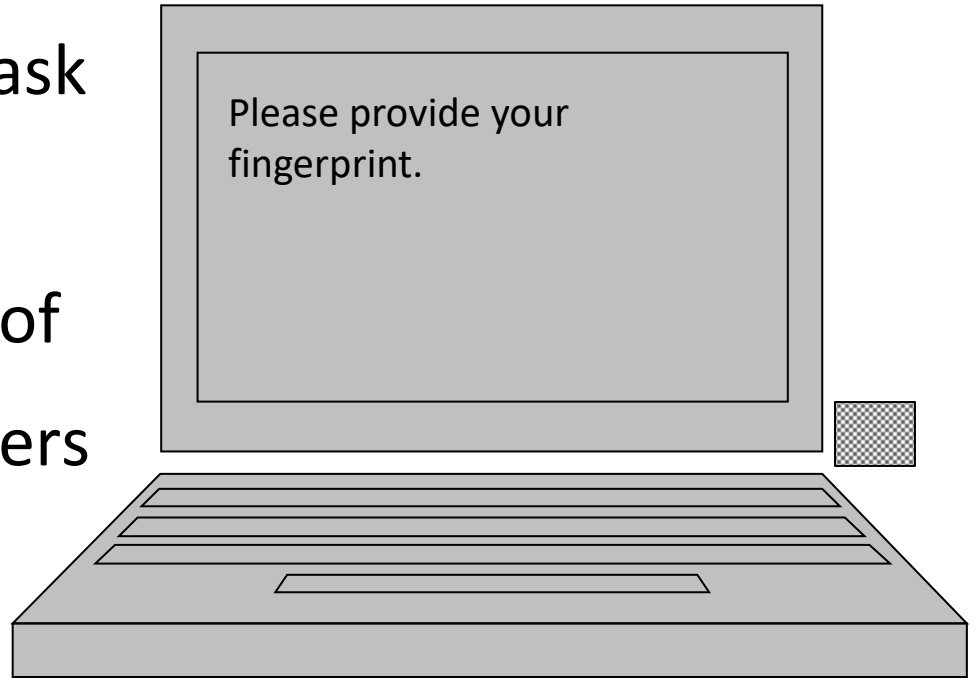
The rise of biometrics

Biometrics can improve security and provide a positive user experience, but be conscious of potential weaknesses



What Can You Do with a Stolen Fingerprint?

1. Convert fingerprint to digital image
2. Clean and invert image to create mask
3. Etch or print 3D mold
4. Add material to create cast, i.e. spoof
5. *(If locally stored biometric),* steal users specific computing device associated with the stolen fingerprint



Fingerprint Reader

Not Easily Scalable

Conventional Wisdom on the Weaknesses of Biometrics

- Biometrics cannot be changed
- Biometrics are not secret

Mitigation of Weaknesses of Biometrics

Ensure that biometric information cannot be inserted beyond the sensor → *Locally Stored Biometric Templates, Security*

Ensure that biometric was measured from the live, authorized individual at that time/place → *Presentation Attack Detection*

Spoofing: Don’t Believe the Hype

THE VERGE TECH REVIEWS SCIENCE ENTERTAINMENT VIDEO FEATURES MORE

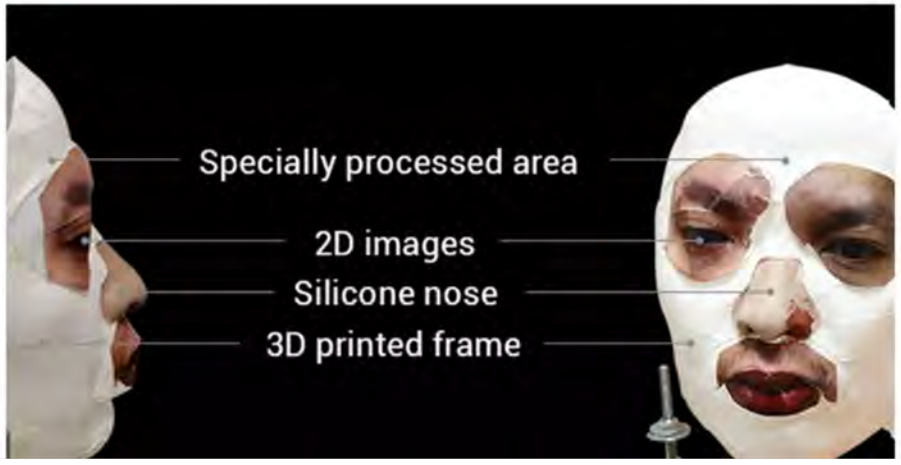
APPLE TECH CYBERSECURITY

This $150 mask beat Face ID on the iPhone X

It's just a proof of concept at the moment

By Thuy Ong | @ThuyOng | Nov 13, 2017, 5:46am EST

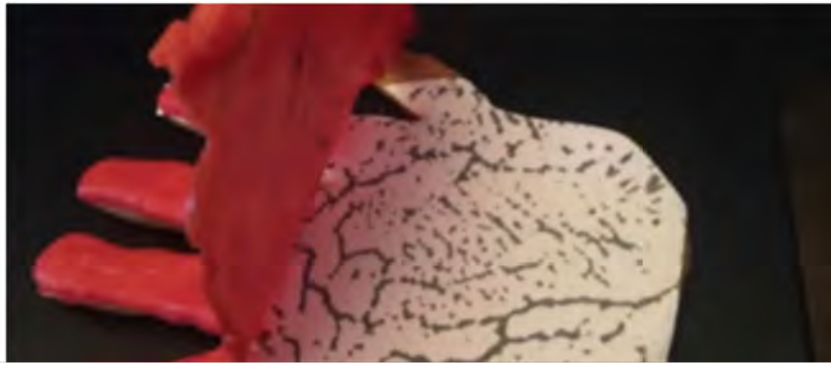
SHARE



MOTHERBOARD Moveable Hacking Environment Space Gaming He

Security researchers disclosed new work at the Chaos Communication Congress showing how hackers can bypass vein based authentication.

SHARE TWEET



PYMNTS.com

SECTIONS TODAY'S NEWS RETAIL B2B OPINION STUDIES TRACKERS PODCASTS MASTERCLASS

Spoofing: But there are practical concerns

The China Post
Since 1952

Top News | Asia

South Korean fools finger printing system in Japan

January 2, 2009

AFP

TOKYO — A South Korean woman barred from entering Japan last year passed through its immigration screening system by using tape on her fingers to fool a fingerprint reading machine, reports said Thursday.

The biometric system was installed in 30 airports in 2007 to improve security and prevent terrorists from entering into Japan, the Yomiuri Shimbun said.

The woman, who has a deportation record, told investigators that she placed special tapes on her fingers to pass through a fingerprint reader, according to Kyodo News.

Japan spent more than four billion yen (US$44 million) to install the system, which reads the index fingerprints of visitors and instantly cross checks them with a database of international fugitives

January 2, 2009

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NEWS

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Doctor 'used silicone fingers' to sign in for colleagues

12 March 2013 Share

A Brazilian doctor faces charges of fraud after being caught on camera using silicone fingers to sign in for work for absent colleagues, police say.

Thaune Nunes Ferreira, 29, was arrested on Sunday for using prosthetic fingers to fool the biometric employee attendance device used at the hospital where she works near Sao Paulo.

Police said they recovered six silicone fingers at the time of the doctor's arrest

She is accused of covering up the absence of six colleagues.

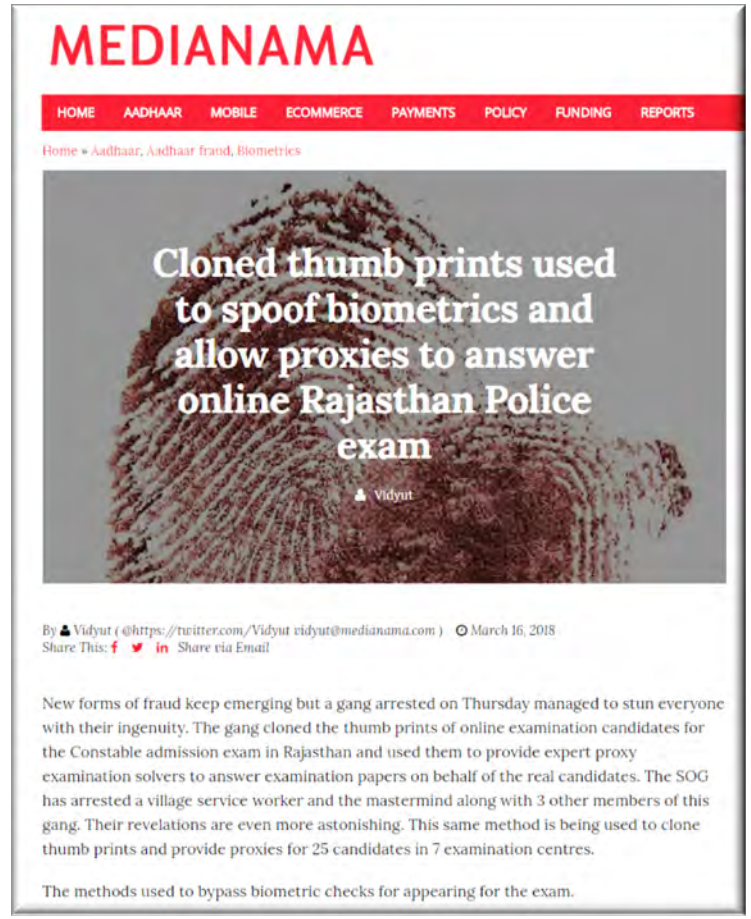
Her lawyer says she was forced into the fraud as she faced losing her job.

The local public prosecutor's office opened an investigation on Monday.

The doctor was arrested by the local police following a two-week investigation in the town of Ferraz de Vasconcelos, and was released on Sunday.

Police said she had six silicone fingers with her at the time of her arrest, three of which have already been identified as bearing the fingerprints of co-workers.

March 12, 2013



MEDIANAMA

HOME AADHAAR MOBILE ECOMMERCE PAYMENTS POLICY FUNDING REPORTS

Home » Aadhaar, Aadhaar fraud, Biometrics

Cloned thumb prints used to spoof biometrics and allow proxies to answer online Rajasthan Police exam

Vidyut

By Vidyut (@https://twitter.com/Vidyut vidyut@medianama.com) March 16, 2018
Share This: Share via Email

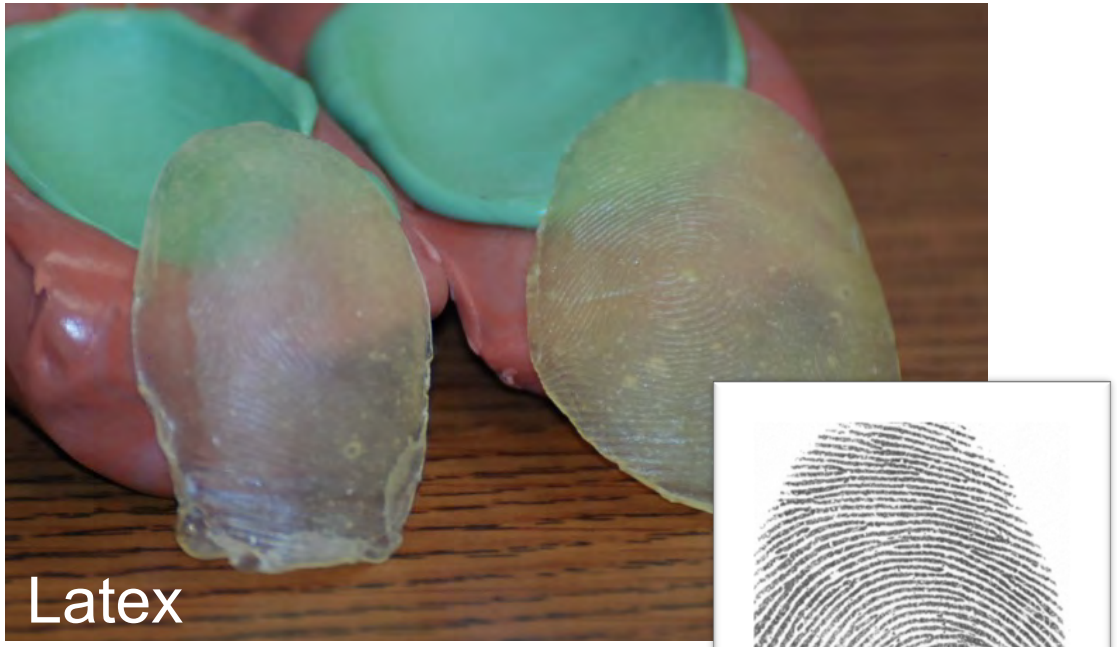
New forms of fraud keep emerging but a gang arrested on Thursday managed to stun everyone with their ingenuity. The gang cloned the thumb prints of online examination candidates for the Constable admission exam in Rajasthan and used them to provide expert proxy examination solvers to answer examination papers on behalf of the real candidates. The SOG has arrested a village service worker and the mastermind along with 3 other members of this gang. Their revelations are even more astonishing. This same method is being used to clone thumb prints and provide proxies for 25 candidates in 7 examination centres.

The methods used to bypass biometric checks for appearing for the exam.

March 15, 2018

Lab-controlled Spoofing

Lab-controlled Spoofing



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Production of Biometric Presentation Attack (Spoof)

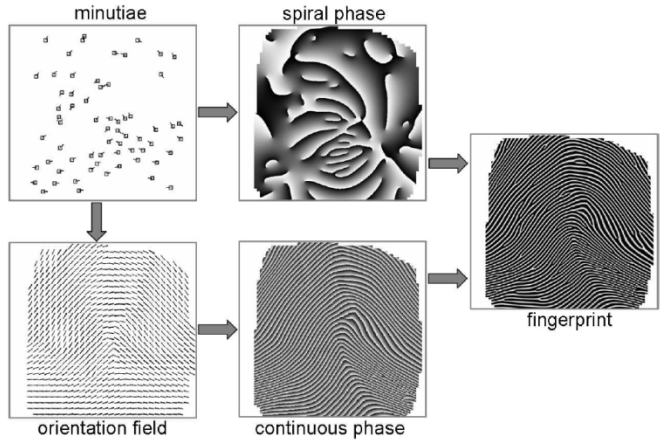
- Production of spoof requires two things
  - (1) Source of biometric characteristic you are replicating
  - (2) Process for creating the spoof

Source of Biometric

- **Cooperative** –Captured directly from individual with assistance (e.g. finger mold, face mask)
- **Latent—**Captured indirectly through latent sample (e.g. latent fingerprint, hair, skin)
- **Recording**—Captured directly from individual onto media (e.g. photograph, video recording)
- **Template Regeneration**
- **Synthetic**–Not mapped to real person (e.g. synthetic fingerprint, iris, wolf sample)
- **Impersonation**—Conversion of natural characteristic to another individual's with artificial assistance (e.g. computer assisted voice)

ISO/IEC CD 30107, Information Technology — Biometrics -- Presentation Attack Detection, Part 3, Table A.1

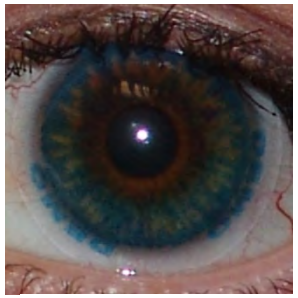
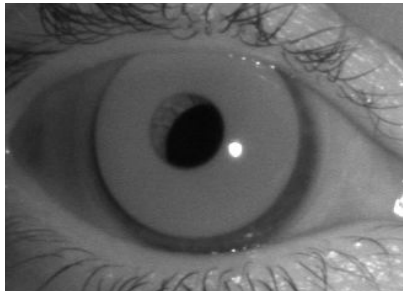
Feng and Jain, Advances in Biometrics article, 2009.



PRODUCTION OF SPOOF

Molds, casts, masks, direct renderings and digital media

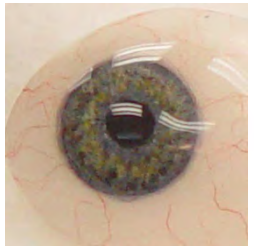


Seelen, "Countermeasures Against Iris Spoofing with Contact Lenses," Iridian Technologies Inc.


Thalheim, et al, C'T article, 2002.

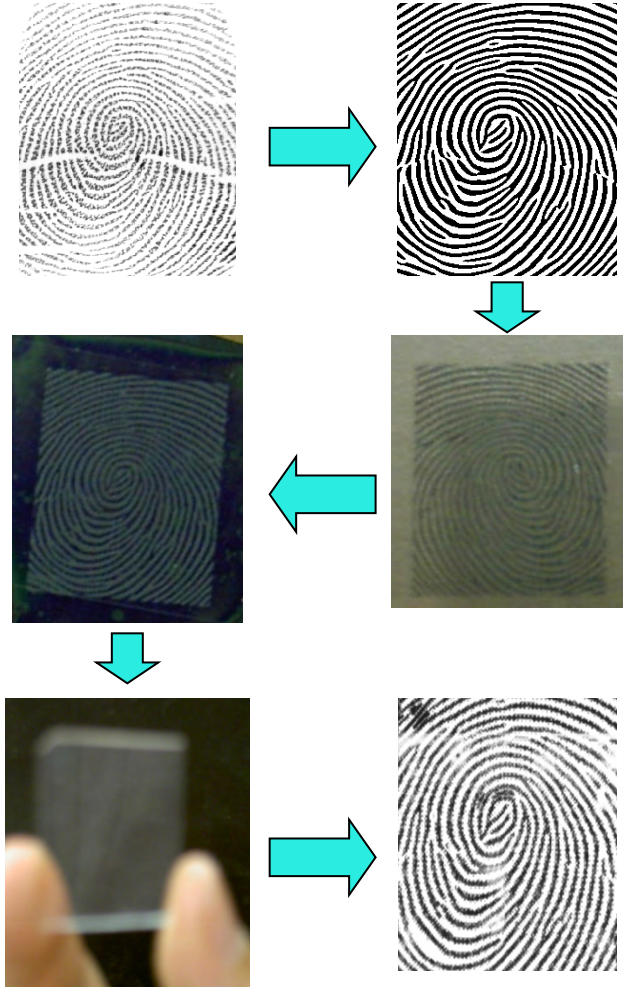
Schuckers, et al, 2002.




Lefohn, et al, IEEE Computer Graphics & Applications article, 2003.

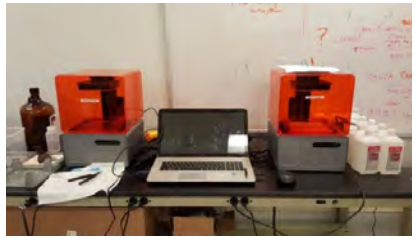
Spoof Creation with Transparency

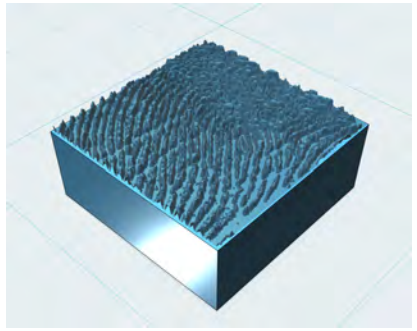
- Uncooperative
- Lifted latent print, stolen fingerprint image
- Fingerprint mask generation
- Print on transparent film
- Expose negative photosensitive silicon wafer
- Develop to form cast
- Pour silicone or other liquid material to form mold

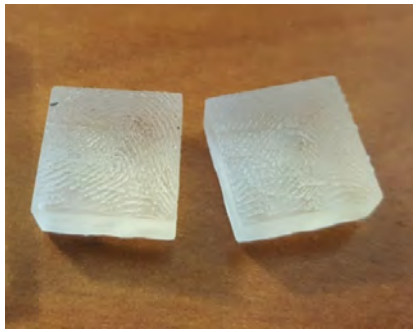


Spoof Creation with 3D Printer

- From fingerprint image, create 3D representation of fingerprint
- Since most 3D printers use rigid materials, print mold
- Create spoofs using mold with traditional materials (e.g. gelatin)







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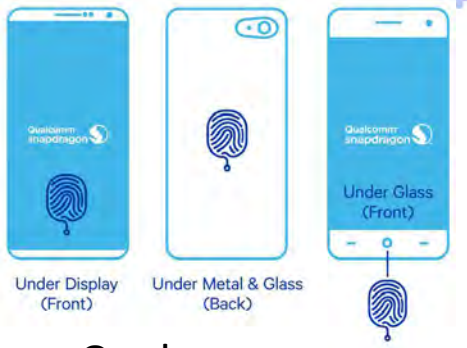
“It is ‘liveness’, not secrecy, that counts.”

Denning, Information Security Magazine, 2001

Fingerprint PAD

- Thousands of academic papers in this area!
- Hardware-based
  - Temperature, pulse, blood pressure, odor, electrocardiogram, multispectral imaging, spectroscopy, ultrasound, electrical characteristics
- Software-based
  - Skin deformation, elasticity, pores, perspiration pattern, power spectrum, noise residues in valleys

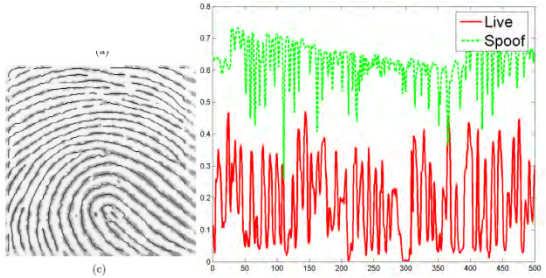


Qualcomm

Fingerprint Cards

Morpho

Lumidigm



Dermalog

Iris PAD

- Hardware-based:
  - Specular reflections, eye movements (e.g., saccades), spontaneous and stimulated pupil size changes, 3D properties (flat iris vs convex textured contact lens), thermal-based features, multi-spectral (melanin absorption as a function of the wavelength vs light absorption by artifacts)
- Software-based:
  - Texture patterns, pixelization, spatial frequency analysis, iris image quality features, deep-learning-based solutions

Iritech Mobile

IrisGuard AD100

iPhone X - Face

- "To counter both digital and physical spoofs, the TrueDepth camera randomizes the sequence of 2D images and depth map captures, and projects a device-specific random pattern." *
- "An additional neural network that's trained to spot and resist spoofing defends against attempts to unlock your phone with photos or masks." *

WIRED

ANDY GREENBERG SECURITY 11.12.17 06:44 PM

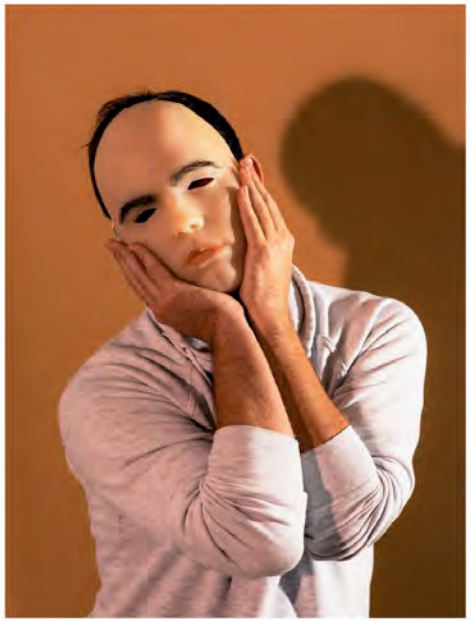
HACKERS SAY THEY'VE BROKEN FACE ID A WEEK AFTER IPHONE X RELEASE

This article has been updated below with another, more convincing video demonstration of Bkav's Face ID spoofing, which the firm revealed two weeks after the original.

When Apple released the iPhone X on November 3, it touched off an immediate race among hackers around the world to be the first to fool the company's futuristic new

ANDY GREENBERG SECURITY 11.03.17 07:00 AM

WE TRIED REALLY HARD TO BEAT FACE ID—AND FAILED (SO FAR)



*FaceID Security Guide, 2017, https://www.apple.com/business/site/docs/FaceID_Security_Guide.pdf

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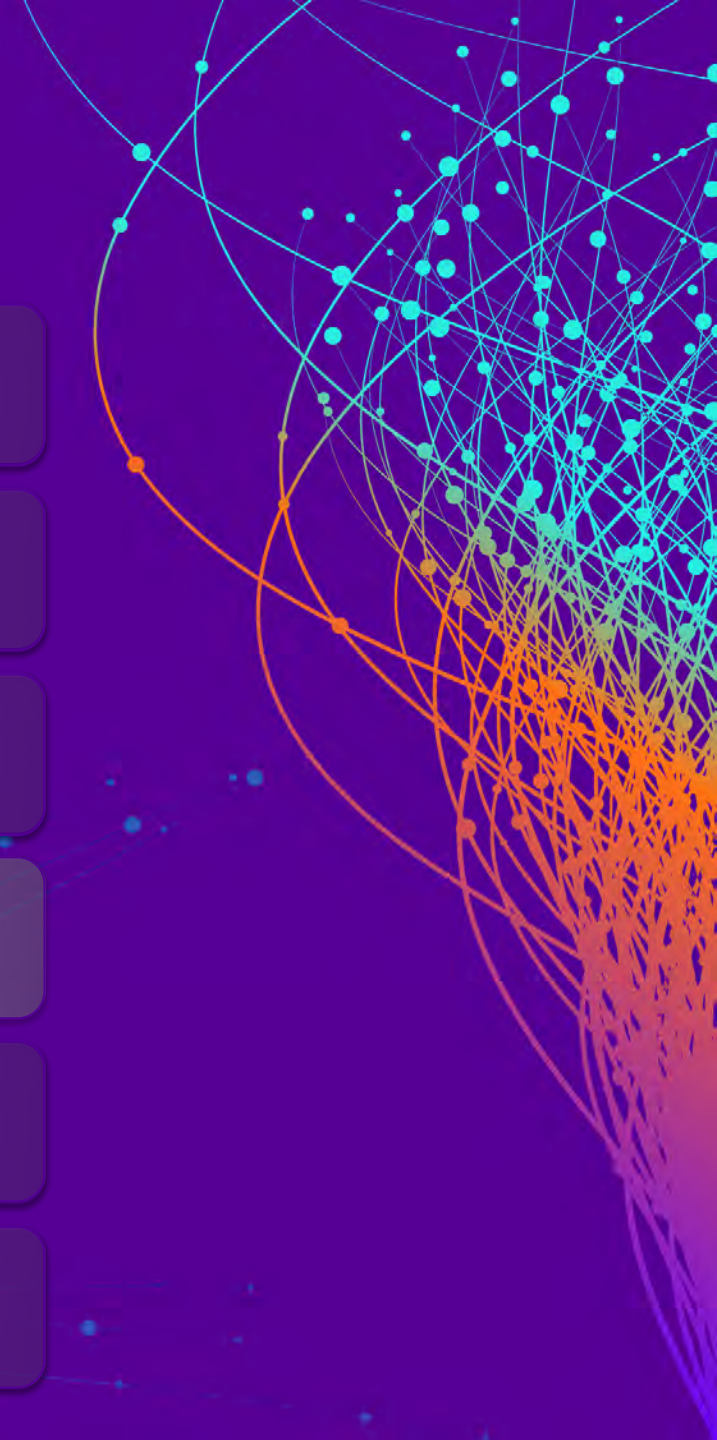
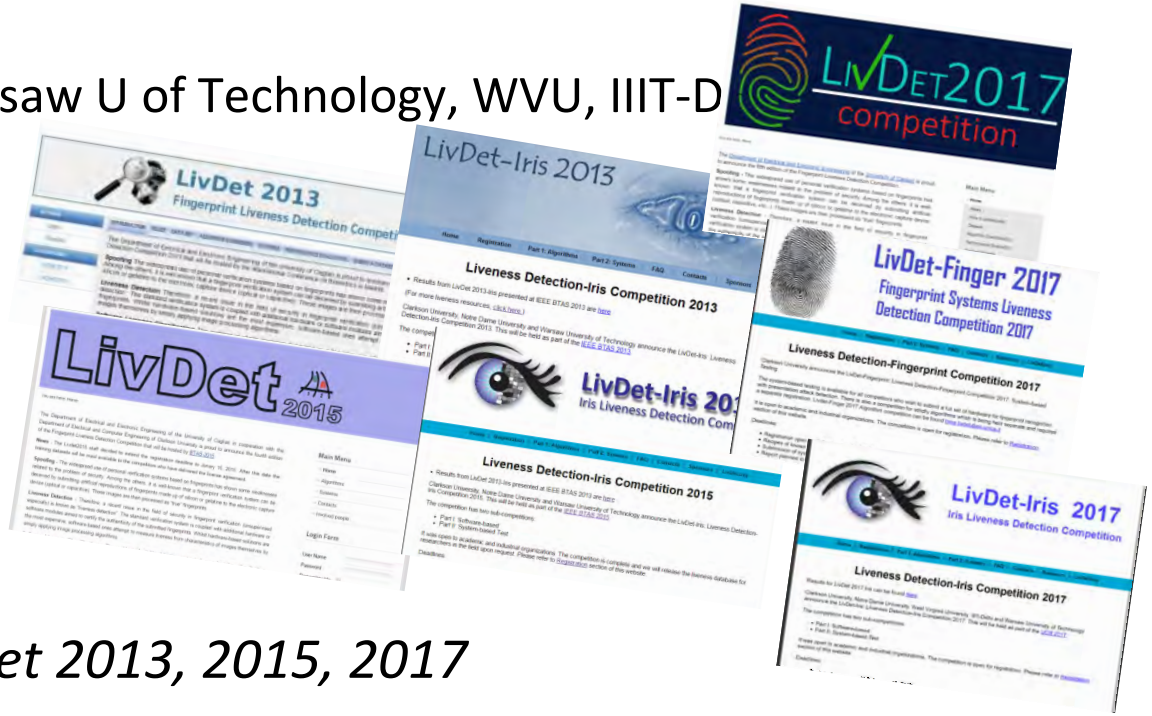


Competitions for Benchmarking

- Liveness Detection Competitions
  - Sense of the State of the Art in the Field
  - Publically available databases to support R&D (even after competitions)
  - Co-host: Fingerprint—Clarkson U & U of Cagliari;
  - Iris—Clarkson U, Notre Dame University & Warsaw U of Technology, WVU, IIIT-D

- *LivDet 2009*
  - Fingerprint Algorithms

- *LivDet 2011*
  - Fingerprint Algorithms
  - Fingerprint Systems

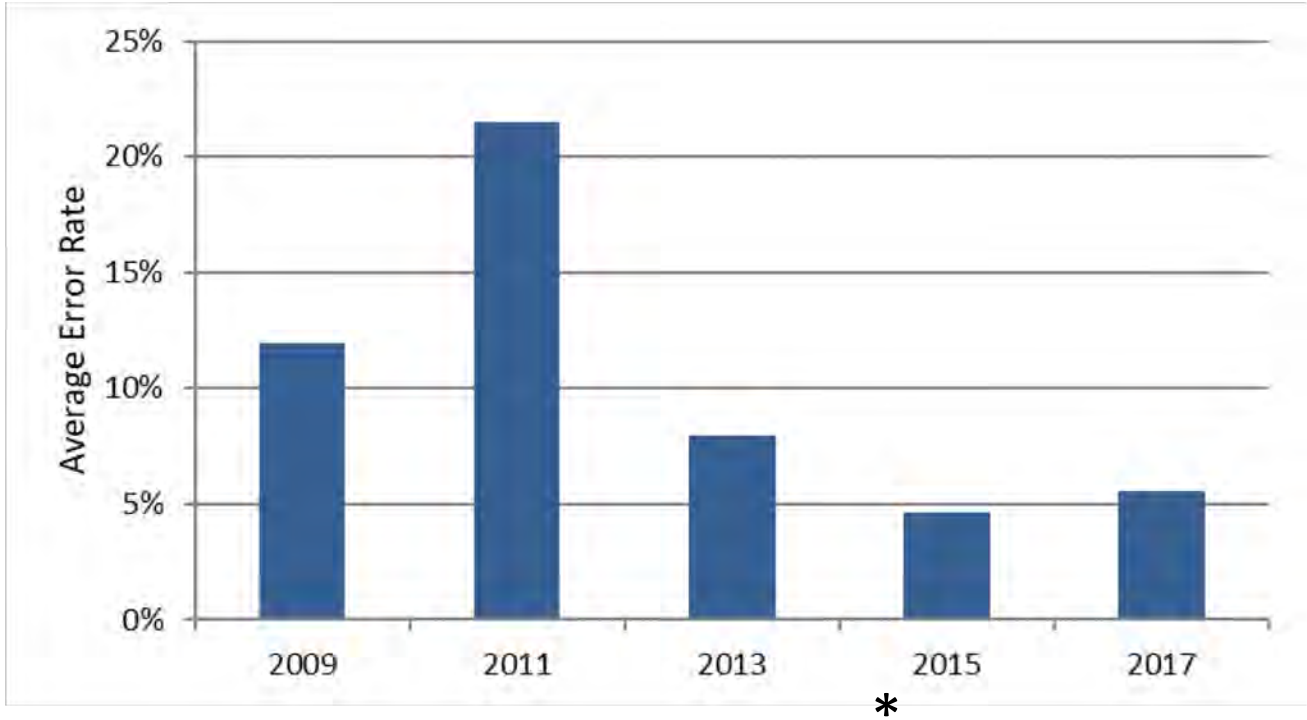


- *LivDet 2013, 2015, 2017*
  - Fingerprint Algorithms
  - Fingerprint Systems
  - Iris Algorithms

http://livdet.org

CITeR Center for Identification Technology Research

LivDet over the years (Fingerprint)



*

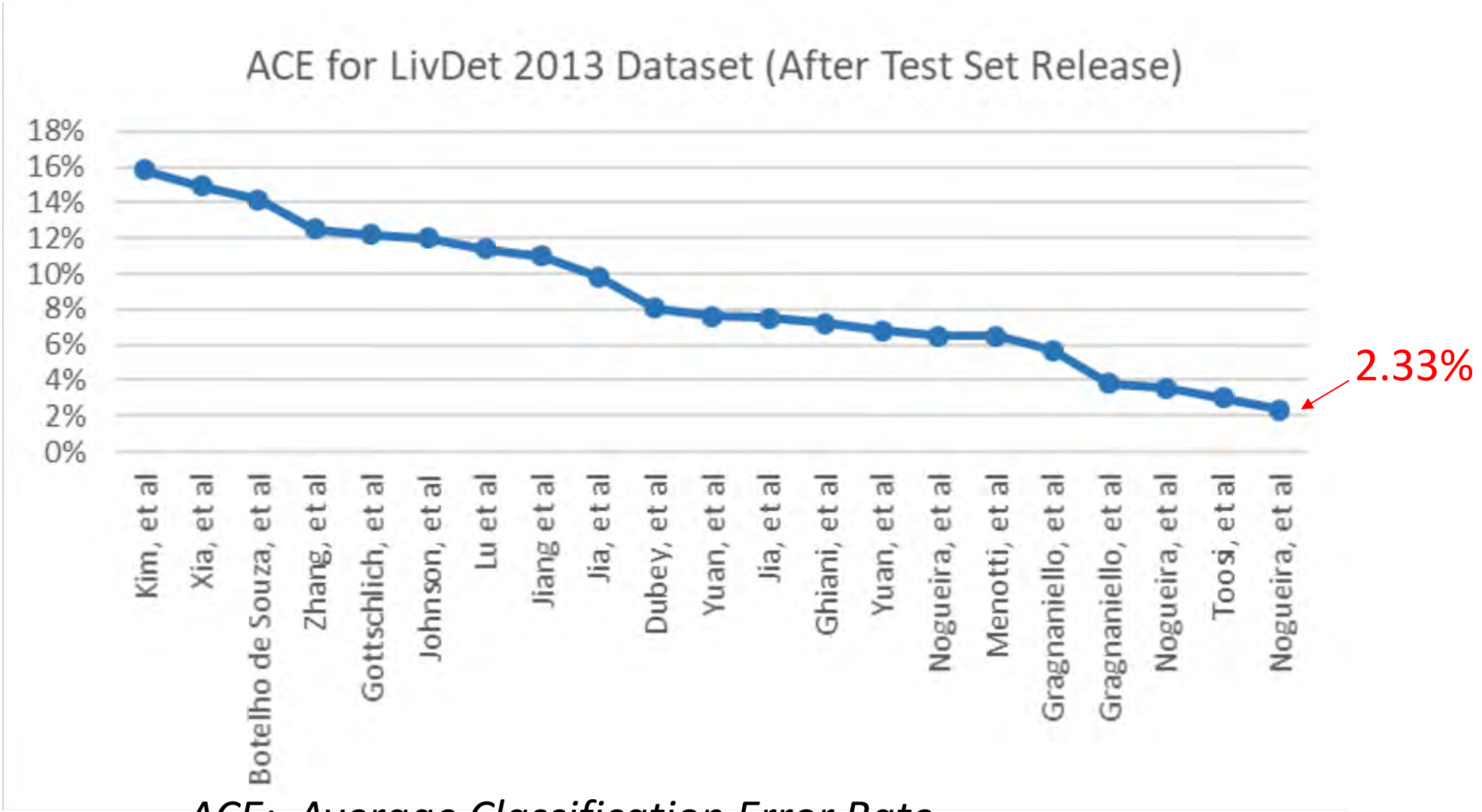
Average of APCER and BPCER for top two performers across all databases tested in LivDet competitions hosted 2009, 2011, 2013, 2015, 2017.

Ghiani, L., Yambay, D.A., Mura, V., Marcialis, G.L., Roli, F. and Schuckers, S.A., 2017. Review of the Fingerprint Liveness Detection (LivDet) competition series: 2009 to 2015. *Image and Vision Computing*, *58*, pp.110-128.

*Crossmatch removed

Results on LivDet data (after test set release)

*Sampling of papers



ACE: Average Classification Error Rate

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ISO Standards for PAD

- ISO/IEC CD 30107, Information Technology — Biometrics -- Presentation Attack Detection
  - Part 1 2016
  - Part 2 2016
  - Part 3 2017
- PAD sub-system metrics:
  - Attack Presentation Classification Error Rate (APCER) – Spoof
  - Bonafide Presentation Classification Error Rate (BPCER) - Live
- Performance metrics
  - False non-match rate, false match rate
  - AND imposter attack presentation match rate
- Tradeoff between the three

Industry Requirements

- Microsoft Windows Hello biometric requirements
  - FAR < 0.002%.
  - Effective, real world FRR with antispoofing or liveness detection <10%.

- Google
  - “MUST have a false acceptance rate not higher than 0.002%.
  - [SR] Are STRONGLY RECOMMENDED to have a spoof and imposter acceptance rate not higher than 7%.
  - [C-1-5] MUST rate limit attempts for at least 30 seconds after five false trials for fingerprint verification.”

Windows Hello biometrics requirements, 05/01/2017, Accessed 9/26/2018.
https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/windows-hello-biometric-requirements

Compatibility Definition, Android 9, August 8, 2018, Google, Accessed 9/26/2018.
https://source.android.com/compatibility/android-cdd.pdf

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Spoofing and Relative "Difficulty"

- How difficult is create a spoof?
- How much time/money? How much expertise/skill?

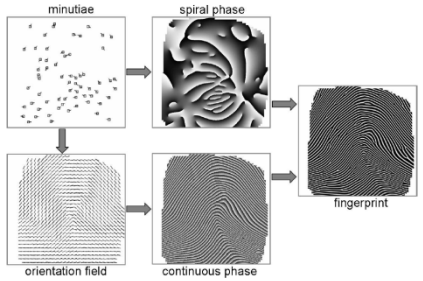
Easy to Create

Difficult to Create

Photo from internet

Cooperative Mold/Cast

Template to Spoof



Spoofing and Relative "Observability"

- How difficult is it to capture the biometric from an individual without their knowledge?
- From a distance? Over the internet?
- Requirements for liveness detection higher if biometric is more "observable"

Face

Voice

Finger

Vein

?

Certification

- BSI Certification based on Common Criteria
  - Morpho 2013
  - Dermalog 2018

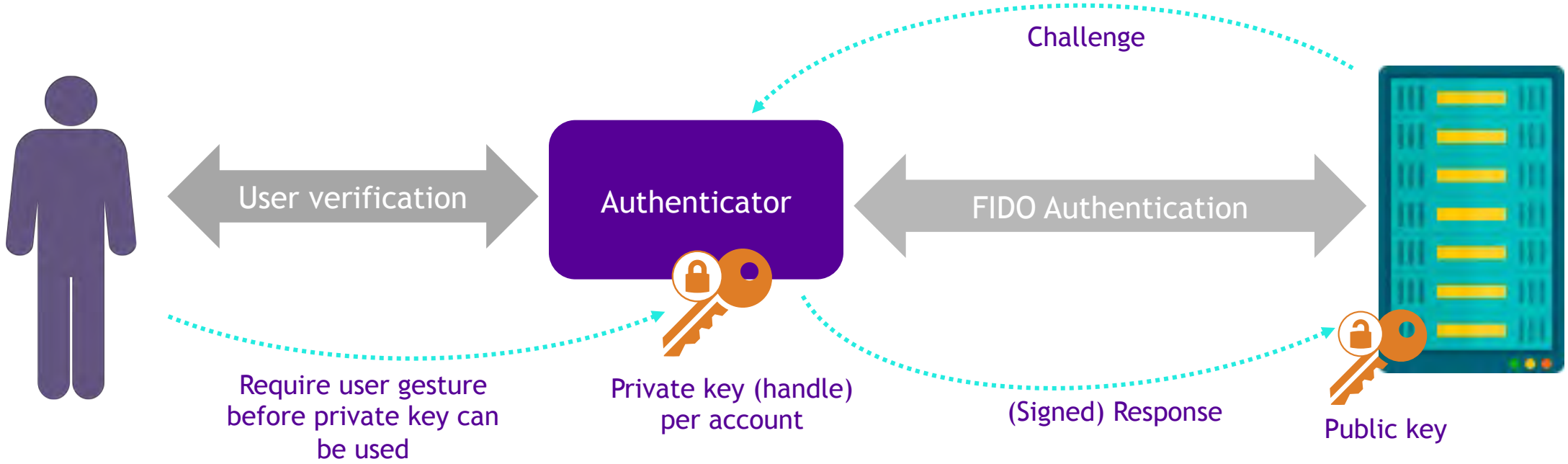
e.g., “Morpho, Common Criteria Certification for Fake Finger Detection”, July 2013

Fingerprint Spoof Detection Protection Profile based on Organizational Security Policies (FSDPP_OSP), Version 1.7, 27 November 2009, BSI-CC-PP-0062-2010

BSI issues Common Criteria certificate for DERMALOG fingerprint scanner, Aug 23, 2018
https://www.bsi.bund.de/DE/Presse/Kurzmeldungen/Meldungen/CC-Zertifikat-Dermalog-220818.html

FIDO Alliance Biometric Certification Program (Mobile)

HOW DOES FIDO WORK?



FIDO IS "HIGH-ASSURANCE STRONG AUTHENTICATION"

High-assurance strong authentication =

- ✓ Use of two + factors 
- ✓ **At least one** leverages public key cryptography 
- ✓ Not susceptible to phishing, man-in-the-middle and/or other attacks targeting credentials

FIDO Certification Purpose

The FIDO Biometric Certification Program is intended to certify biometric components and/or subsystems and is independent from Authenticator Certification Program.

fido ALLIANCE simpler stronger authentication

What is FIDO? Blog Get Involved Search...

ABOUT TECHNOLOGY ADOPTION PARTICIPATE FIDO CERTIFICATION NEWS & EVENTS RESOURCES

FIDO Alliance Launches Biometrics Certification Program

September 6, 2018

Program certifies that biometric recognition systems meet globally recognized performance standards and are fit for commercial use

MOUNTAIN VIEW, Calif., September 6, 2018 – Biometric user verification has become a popular way to replace passwords and PINs, but the lack of an industry-defined program to validate performance claims has led to concerns over variances in the accuracy and reliability of these solutions. To fill this gap, the FIDO Alliance today announced its Biometric Component Certification Program – the first such program for the industry at large. The program utilizes accredited independent labs to certify that biometric subcomponents meet globally recognized performance standards[i] for biometric recognition performance and Presentation Attack Detection (PAD)[ii] and are fit for commercial use.

The FIDO Alliance aims to deliver several benefits to providers and users of biometric recognition systems through the new Biometric Component Certification Program. Until now, due diligence was performed by enterprise customers who had the capacity to conduct such reviews. This required biometric vendors to repeatedly prove performance for each customer. The FIDO Alliance program allows vendors to test and certify only once to validate their system's performance and re-use that third-party validation across their potential and existing customer base, resulting in substantial time and cost savings. For customers, such as regulated online service providers, OEMs and enterprises, it provides a standardized way to trust that the biometric systems they are relying upon for fingerprint, iris, face and/or voice recognition can reliably identify users and detect presentation attacks.

"The lack of standards has long been an issue in biometrics, forcing security professionals to 'get deep in the weeds' to not only understand the attributes that are important but subsequently evaluate vendors on those attributes. An unbiased Alliance-based certification program expedites solution evaluation for companies but also eases adoption by providing assurances to the C-suite of proper choice," said Frank Dickson, research vice president, IDC.

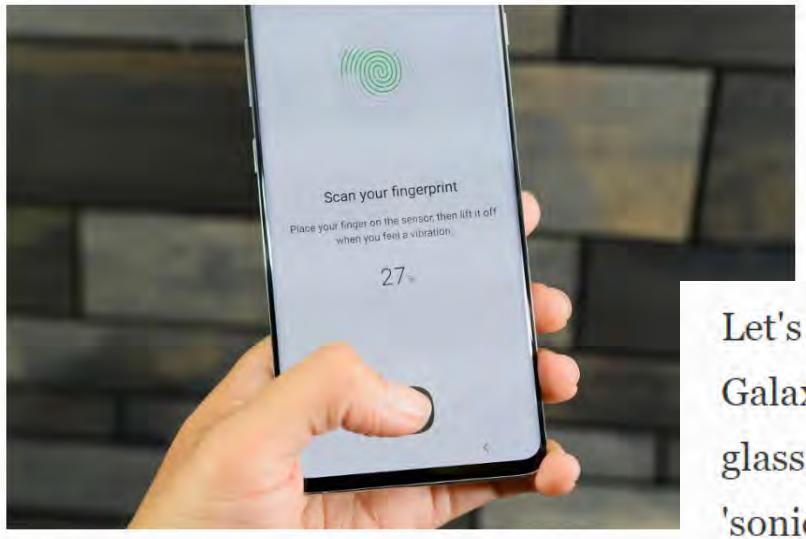
"With biometrics being a popular option for mobile and web applications implementing FIDO Authentication, there is a growing need for those service providers to appropriately assess the risk of fraud from lost or stolen devices. While border control and law enforcement markets have mature assessment programs for their biometric systems, we were surprised that no such program existed for this rapidly growing consumer market," said Brett McDowell, executive director of the FIDO Alliance. "As an organization that is driven by our members' real-world business requirements, and already experienced at delivering globally scalable high-quality certification programs, the FIDO Alliance was the organization our members chose to fill this gap in the market."

FIDO Biometric Component Certified

Forbes

Samsung Confirms Galaxy Fold And S10 Security Surprises

Davey Winder Contributor ⓘ
Cybersecurity
I report and analyse breaking cybersecurity and privacy stories



GETTY

Feb. 23, 2019

Let's start with what's got what and what hasn't got so much. The new Galaxy S10 and S10+ models do get the new in-display, under-the-glass, FIDO Alliance Biometric Component certified, Qualcomm 3D 'sonic sensor' ultrasonic fingerprint scanner. I never minded the round

BIOMETRIC PERFORMANCE REQUIREMENTS

- Evaluation framework and certification program – Independent Laboratory Verification of Vendor Claims
- References ISO Standards
  - 19795 Biometric performance testing and reporting
  - 30107 Presentation attack detection
- Testing plan focuses on:
  - Consistent set of tests for different implementations under test submitted by vendors
  - Supporting different modalities of biometrics
  - False accept rate (FAR)
  - False reject rate (FRR)
  - Imposter attack presentation match rate (IAPMR) (*artefact success rate*)
- Testing program will be implemented by approved third party testing laboratories (accredited by FIDO Alliance)

PAD Requirements

"PAD Light"…

Provide guidelines for testing low level spoof attacks (those which require minimal expertise)

Testing performed on biometric sub-system provided by vendor

Measures Imposter Attack Presentation Match Rate (IAPMR)

- IAPMR: Proportion of presentation attacks in which the target reference is matched. From ISO 30107 Part 3
- Each spoof type measured separately

Attacks triaged into levels

- Low level attacks require less time/knowledge/equipment
- Testing will only include "known" attacks
- "Unknown" attacks reserved for future certification

Evaluation Process

- Each subject enrolled as non-artifact
- Testing with at least 10 PAI species* per enrolled subject
- "Unknown" attacks reserved for future certification

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**Presentation Attack Instrument (PAI) -Biometric characteristic or object used in a presentation attack*
PAI Species - Class of presentation attack instruments created using a common production method and based on different biometric characteristics (ISO/IEC 30107-3)

Spoof Type Triaged by Attack Potential

		Fingerprint	Face	Iris/Eye	Voice
Level A	***Time***: <1 day ***Expertise***: layman ***Equipment***: standard	paper printout, direct use of latent print on the scanner	paper printout of face image, mobile phone display of face photo	paper printout of iris image, mobile phone display of iris photo	replay of audio recording
	Source of biometric characteristic: easy to obtain	lift of fingerprint off the phone	photo from social media	photo from social media	recording of voice
Level B	***Time***: <7 days ***Expertise***: proficient ***Equipment***: standard, specialized	fingerprints made from artificial materials such as gelatin, silicon.	paper masks, video display of face (with movement and blinking)	video display of an iris (with movement /blinking); paper printout w/ contact lens/doll eye	replay of audio recording of specific passphrase, voice mimicry
	Source of biometric characteristic: moderate	Lift of latent print from elsewhere, stolen fingerprint image Cooperative molds - out of scope	video of subject, high quality photo	video of subject, high quality photo	recording of voice of specific phrase
Level C	**Time**: >7days **Expertise**: expert(s) **Equipment**: specialized. bespoke	3D printed spoofs	silicon masks, theatrical masks,	contacts lens or prosthetic with a specific pattern	voice synthesizer
	Source of biometric characteristic: difficult	3D fingerprint information from subject	3D face information from subject	high quality photo in Near IR	multiple recordings of voice to train synthesizer

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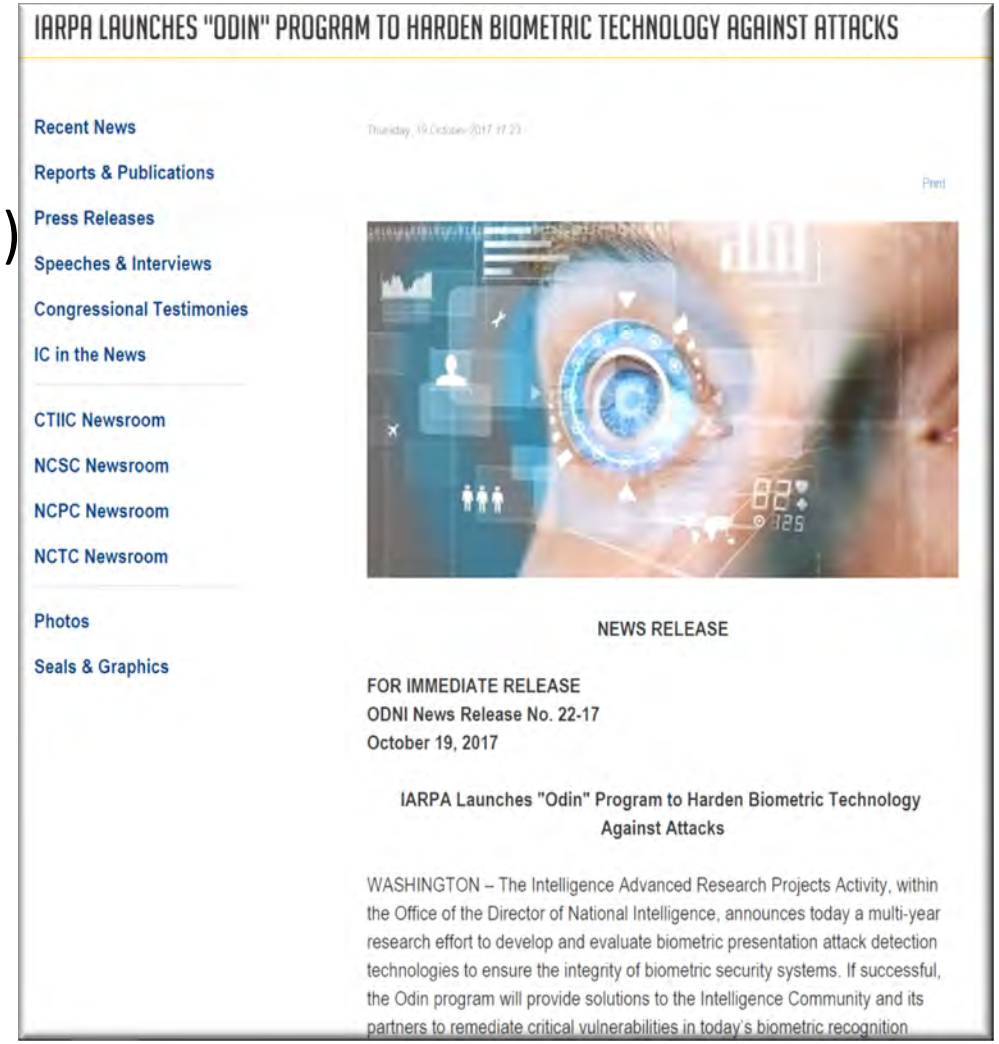
What's Next?

Challenges

- Adoption of Biometric Certification
  - Certification program is relatively new (Fall 2018)
  - Need to drive adoption
  - Ask if biometric products are certified
- Address Zero-Day Attacks (“Unknown” attacks)
  - Part of LivDet evaluations
  - Focus of USA IARPA Odin effort
  - Expected to become part of future FIDO biometric certification



IARPA LAUNCHES "ODIN" PROGRAM TO HARDEN BIOMETRIC TECHNOLOGY AGAINST ATTACKS

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NEWS RELEASE

FOR IMMEDIATE RELEASE
ODNI News Release No. 22-17
October 19, 2017

IARPA Launches "Odin" Program to Harden Biometric Technology Against Attacks

WASHINGTON – The Intelligence Advanced Research Projects Activity, within the Office of the Director of National Intelligence, announces today a multi-year research effort to develop and evaluate biometric presentation attack detection technologies to ensure the integrity of biometric security systems. If successful, the Odin program will provide solutions to the Intelligence Community and its partners to remediate critical vulnerabilities in today's biometric recognition

USA, IARPA Odin Program, https://www.iarpa.gov/index.php/research-programs/odin

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Authentication Technology Landscape

Biometric Presentation Attacks
(Methods, Framework)

Next Gen Technology
(The role of liveness in detection)

Benchmarking (Competitions, Datasets)

Standards & Requirements (ISO, platforms)

Certification
(FIDO, Common Criteria)

Apply what you have learned today

- Next week you should:
  - Identify applications of biometric recognition in your organization
  - Determine if biometric templates are locally stored
  - Explore authentication based on locally stored biometrics (e.g. FIDO)
- In the first three months following this presentation you should:
  - Understand security risks associated with presentation attacks for your organization
  - Define appropriate biometric requirements for organization or product
- Within six months you should:
  - Adopt authentication based on locally stored biometrics which your organization's requirements
  - Require vendors to have completed biometric certification

1993

"On the Internet, nobody knows you're a dog."

Peter Steiner, The New Yorker, July 5, 1993

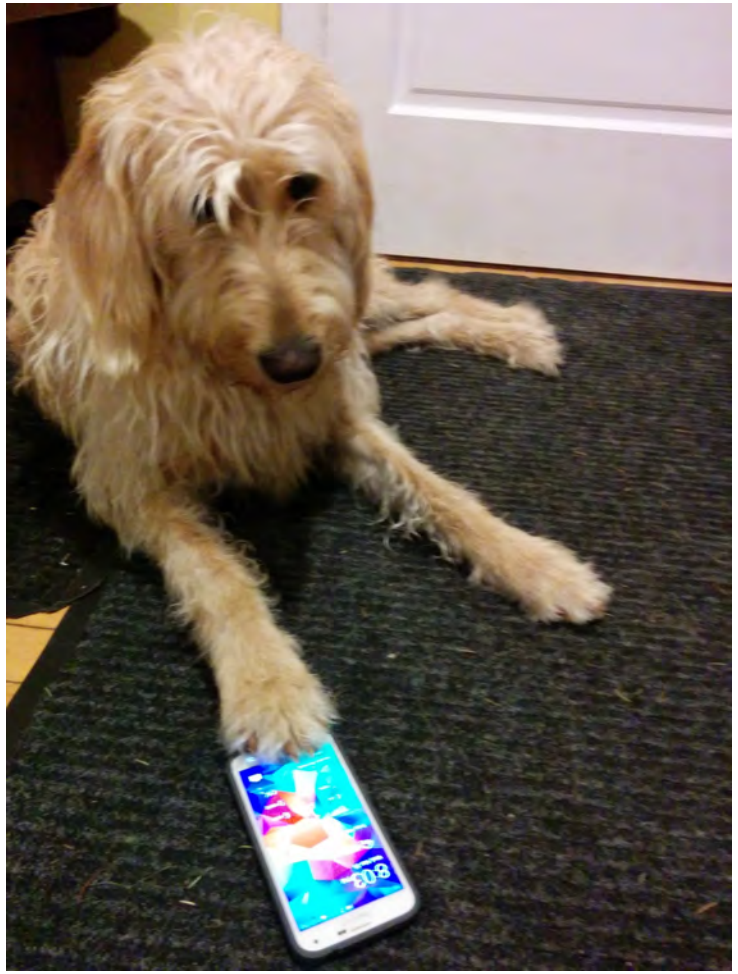
2015

Kaamran Hafeez, The New Yorker, February 23, 2015

20??

Can we have it all?

Identity technologies without revealing private data



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Questions?

Thank you!