

Secure Wireless Transmission of Fingerprint Lifts



The
University
Of
Sheffield.

Nigel M Allinson
University of Sheffield, UK

Ian Gledhill
Lincolnshire Police, UK



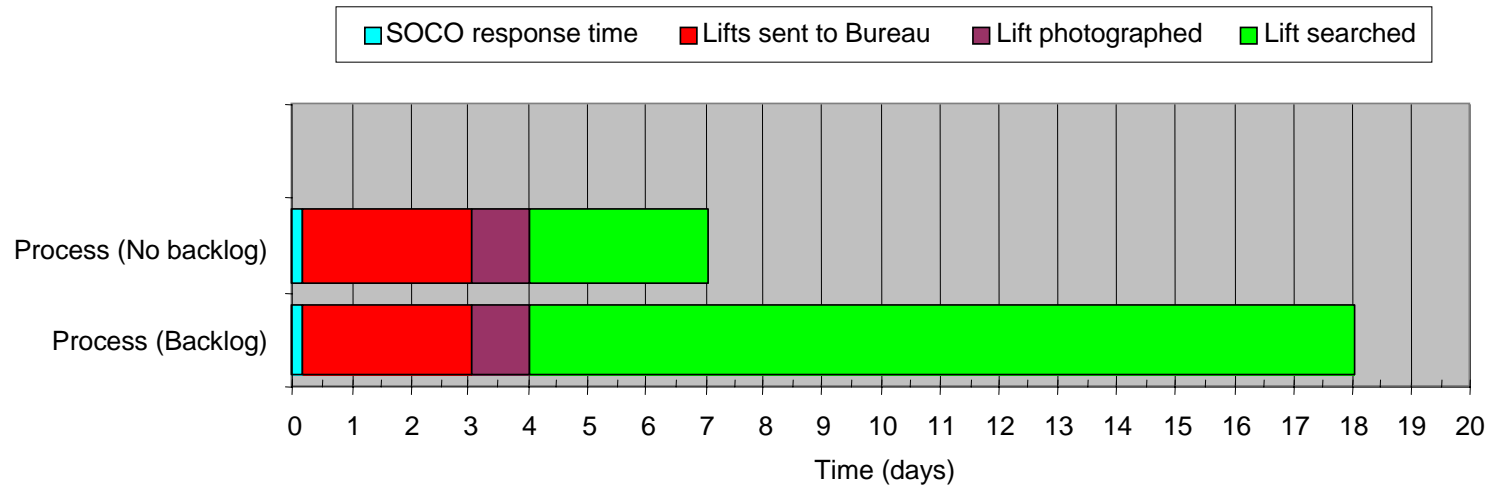
Current Process



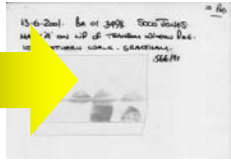
SOCO attends scene

Force bureau

Evidence (lifts): Crime to Ident



Proposed Process



Same Day Response

- 3am Burglary
- 9am SOCO at Scene
- 10am Fingerprint in Bureau
- 12am Ident to Division – Suspect Sought



Cellular Wireless
Network

Mailserv
GMCI



NAFIS (now Ident 1)
Some 6 million TP sets
Some 1 million Marks



Cellular Radio Capabilities

Full lift:	15 cm x 10 cm
Scan:	500 dpi at 8-bit grayscale
Raw data size:	244 KB/sq. inch 37.8 KB/sq. cm
Typical mark: <i>Taped region</i>	1.5 – 3.0 MB

Practical data transmission rates

GPRS (2.5G)

- Good coverage (99% claimed!)
- Data rate (per slot) = 14.4 Kbps (theoretical)
- Normally use two/four slots simultaneously (HSCSD)
- Theoretical = 57.6 Kbps; In Practice ~20 – 45 Kbps

Typical transmit times

4 – 20 mins

UMTS (3G)

- Will never provide nationwide coverage
– 3G in urban areas and GPRS in rural
- Data rates depend on cell size (and other factors)
- Theoretical maximum of 2 Mbps (picocell)
- Expect a maximum (upstream) transmit rate ~144 Kbps

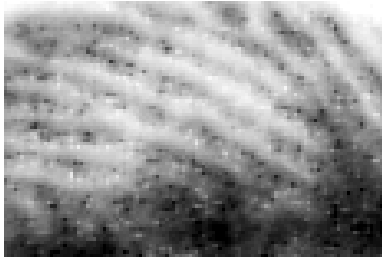
Airwaves

- Dedicated secure digital radio network for UK emergency services
- Based on TETRA – not a unique wireless protocol but an overall system
- Theoretical maximum of 4.8 Kbps; Typically 3 Kbps

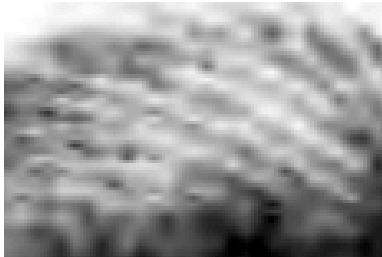
1 – 2 hours!

Compression Options

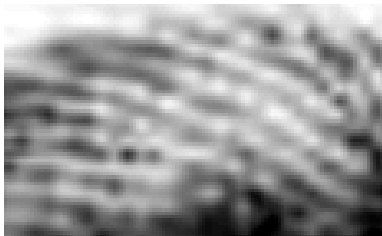
~~JPEG~~ JPEG2000 WSQ



Raw lift image

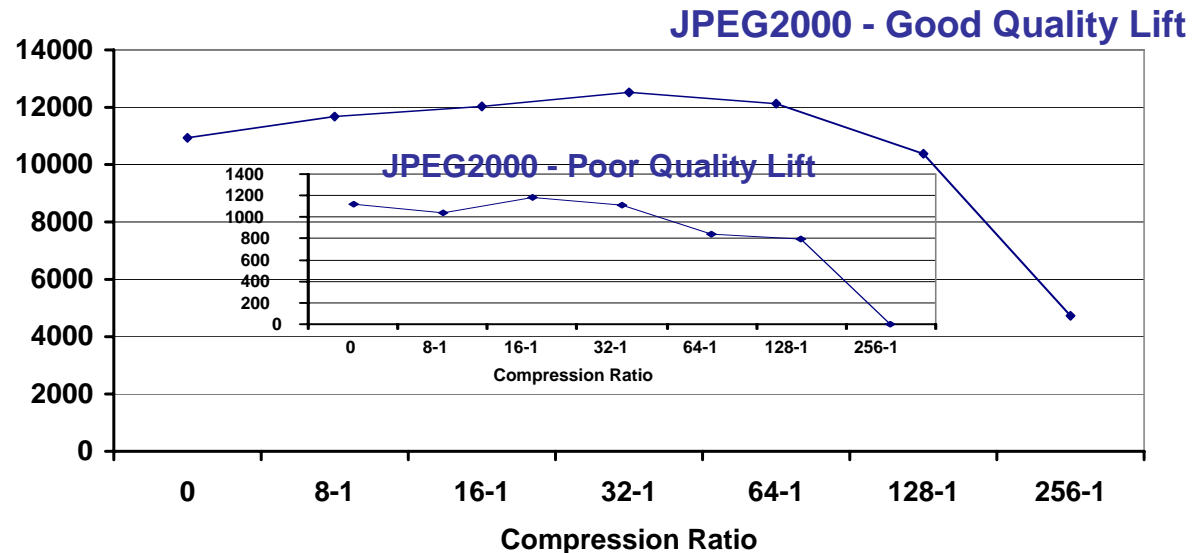


JPEG2000 image (16:1)



WSQ image (16:1)

- Focus on WSQ and JPEG2000
- Range of tests using representative lift sets
- Use autoencoding score as main metric
- Attempt to relate score to various image quality metrics (Results very inconclusive)
- Moderate levels of compression improved autoencode score
- JPEG2000 consistently outperformed WSQ (slight improvement – not statistically significant)
- Decide on 16:1 JPEG2000 compression for future trials
- Lift transmission times – 20 - 80 secs



Lincolnshire Trial

- Outcomes over 9 month trial (2005)
- Standard operating practices
- No additional monitoring
- Individual SOCOs make decision on how to send each lift

	Transmission Mode		Total
	Traditional	Wireless	
Cases analysed	1086	329	1415
	76.7%	23.3%	
Lifts submitted	2812	856	3668
No-value lifts	735	190	925
% no-value	26.1%	22.2%	
Average lifts per visit	2.6	2.6	
Idents achieved	161	59	220
% idents	<u>14.8%</u>	<u>17.9%</u>	

Difference in successful idents is not significant ($\chi^2 = 1.86$)

Conclusion – Transmission mode has no effect or some biased selection of lifts (conscience or otherwise) may hide skew

Difference in no-value lifts is significant at $p \leq 0.025$ ($\chi^2 = 5.41$)

Conclusion – Appropriate compression aids mark-up (tentative)

Validation

Need to demonstrate that lifts either *wireless/traditional* are from same parent population

Method

Took random sampling of physical lifts (about 1 in 15)

Presented to independent panel of 5 fingerprint experts who are asked to rate *lift quality* on 5 point Likert scale

Experts' quality evaluation analysed using an independent-measures factorial ANOVA with transport mode being one IV (Condition 1 = wireless transmission; Condition 2 = road transport), and the quality ratings as the second IV

No main effect between the Conditions ($F(1, 528) = 0.03$) – conclude all lifts from same population and hence transmission mode has no effect on idents achieved

But there was a main effect between Experts ($F(5,528) = 3.94, p < 0.005$). A Tukey HSD *post hoc* revealed a significant pairwise variation between the quality rating used by several experts

Compressed Image Storage

Confirm suitability of compressed images for storage on NAFIS

- Test set of 30 representative lifts
- Generate 30 uncompressed TIFF images and 30 compressed JPEG2000 (16:1)
- 5 cases created with TIFF images and 5 with JPEG2000
- All images loaded, aligned and cropped independently
- Finger selected and entered to Unidentified Mark Database (UDM)
- 12 Fingerprint Officers select a case and undertake a MK/TP search (but do not initiate search)
- Randomised design with 10 chemical lifts as foils
- All cases launched independently for National Search
- Record “HIT/MISS”, autoencode score and rank

- Repeat for TP/MK searches

Results

Appropriate statistical test is to compare image type using a paired t-test that there is no statistical difference in TP/MK scores for the 12 expert fingerprint officers, that is:

H_0 : There is no statistical difference between scores for uncompressed and compressed images.

H_1 : There is a statistical difference between scores for uncompressed and compressed images (two-tailed test)

Can use a parametric test as scores are taken as marks (idents recorded) out of 15.

Paired Samples Test

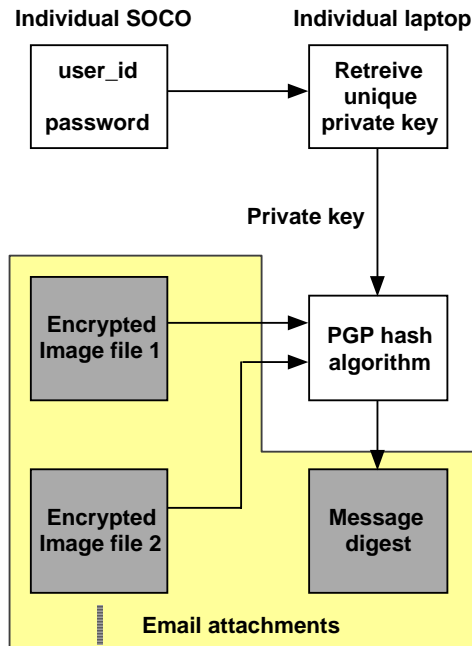
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Tiff MK-TP - Jpeg MK-TP	-.3636	2.11058	.63636	-1.7815	1.0543	-.571	10	.580
Pair 2	Tiff TP-MK - Jpeg TP-MK	.8182	4.91565	1.48212	-2.4842	4.1206	.552	10	.593

H_0 can be accepted. However, statistical tests are designed to err on the side of caution in not rejecting H_0 . Necessary to calculate the *power* of these tests (guard against Type II errors)

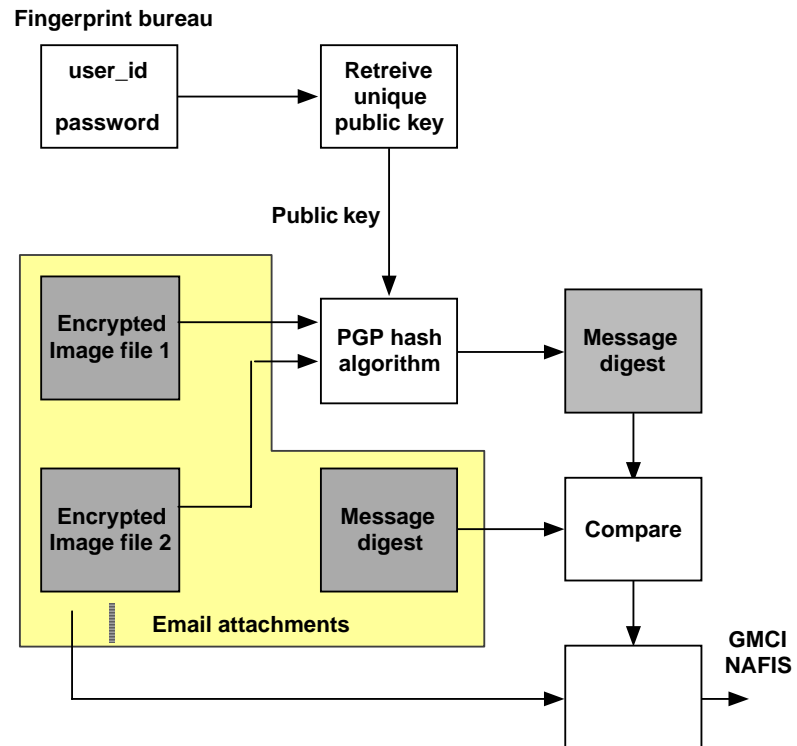
For MK/TP: 92% probability in being correct to assume no difference in uncompressed and compressed images in recovering idents for MK/TP searches.

For TP/MK: 86% probability in being correct to assume no difference in uncompressed and compressed images in recovering idents for TP/MK searches.

Security



Source (SOCO) message security



Fingerprint bureau message security

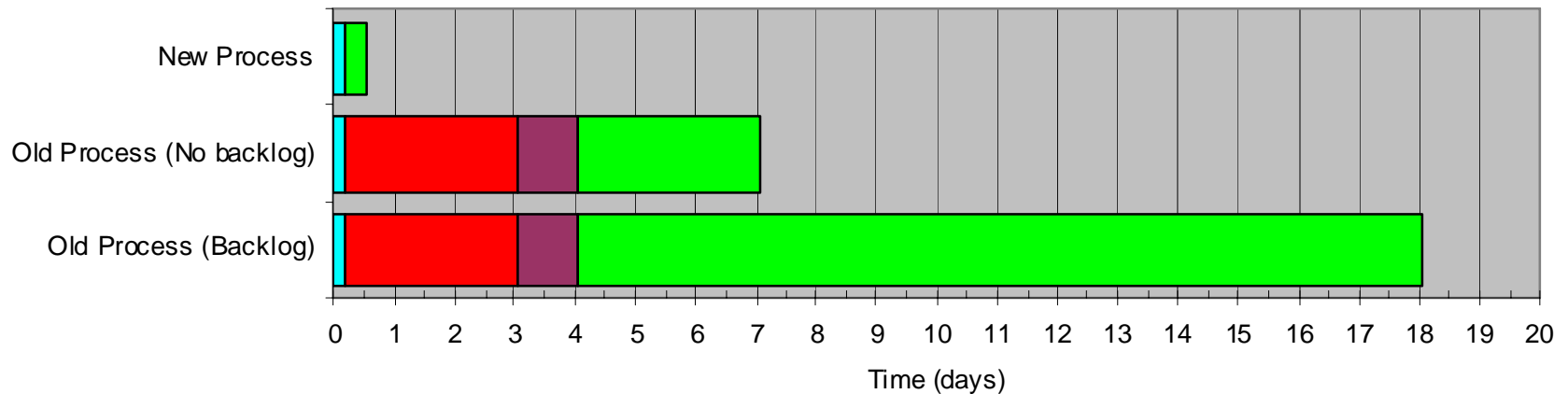
Full Integrated Application Software

- Integrated PGP File Encryption and File Signing
- Simple PKCS12 Keystore interface to manage Security Certificates and Keys
- Certified WSQ and JPEG2000 codecs included
- Various options: group keys for bureau, no image encryption, attach any file, etc.
- Java-based, operates on any Windows platform, universal Twain driver for scanner

Outcomes

Evidence (lifts): Crime to Ident

■ SOCO response time ■ Lifts sent to Bureau ■ Lift photographed ■ Lift searched



- **Full system approved by National Fingerprint Board**
 - 17 January 2006
- **Roll-out event of this approved package all 43 Police Forces (England, Wales and NI)**
 - 27 April 2006

- Crime caused much concern in the town and lots of pressure to solve it
- Acting on intelligence from the town (but nowhere near enough to charge) police raided a flat above a pub where suspect lived

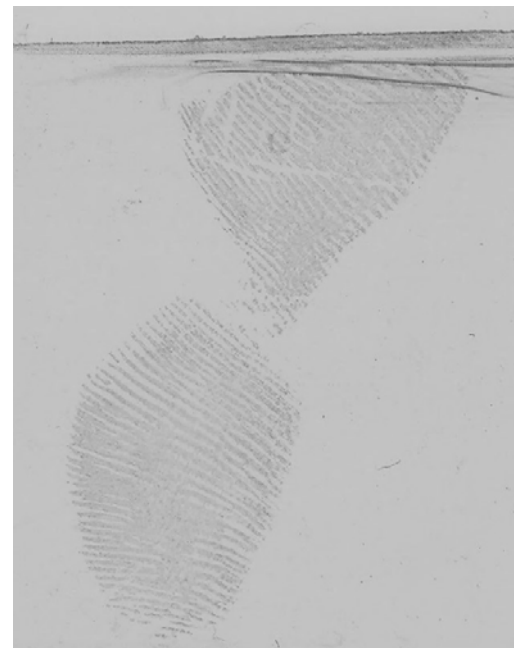
- Unfortunately search did not reveal any property from robbery
- Well-grounded concern that if released he would vanish.
- Only possibility were the keys to a stolen vehicle found in his girlfriend's pocket
- Could not hold suspect on this and became vitally important to place the suspect in the car - with time running out.

- Car was found nearby, SOCO searched vehicle and found print on the mirror. In 20 minutes, it was sent from scene to bureau and identified

- The week he was remanded for car theft was sufficient for CCTV of him following the lady through the town to be collected plus other evidence. He was charged with robbery and attack following week.

Case Study 1

Robbery and vicious beating of a 92 year old in Gainsborough



TEENAGE drug addict Charles Francis stalked a frail 92-year-old woman

by Paul Whitelam

Francis (17) was taken to a hospital where he was diagnosed with a brain tumour. Mrs Douce was left paralysed and unable to walk. She was found in a pool of blood. Francis was charged with the robbery and the assault. He was remanded in custody for four years.

Who would do this to a 92-year-old woman?

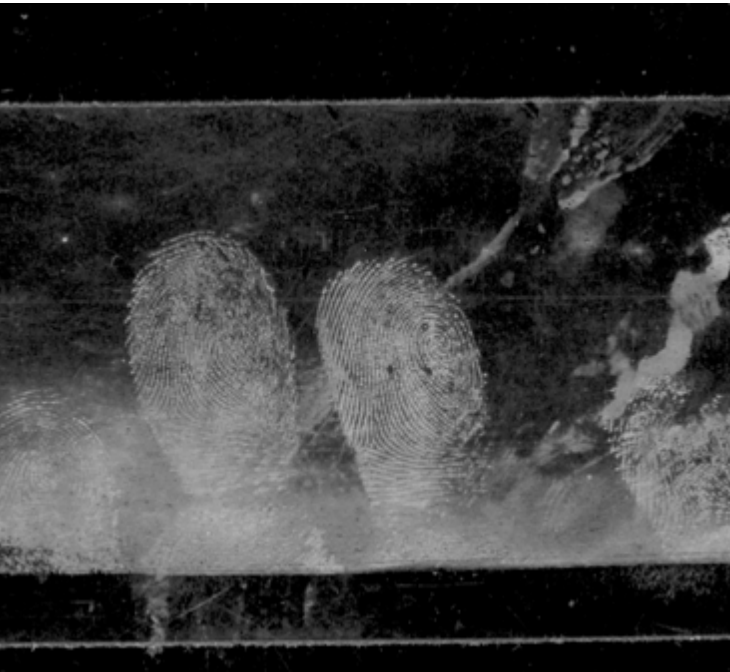
Francis was charged with the robbery and the assault. He was remanded in custody for four years.

GUilty: Charles Francis (17) has been given four years for assaulting 92-year-old Lily Douce in Gainsborough last year. Picture: Ian Jubb. Picture reference: 5-2950-1.

INSET: How the Echo reported the story.

Brave Lily can finally shed a tear... see Page 2.

Case Study 2



The Case of the Severed Finger

- On 12th September 2005, a burglar was chased from industrial premises in Maidenhead in the Thames Valley Police area, jumped from the roof onto a fence, tore his little finger off and managed to escape
- Finger was recovered and taken to local fingerprint bureau. Unfortunately local bureau was being upgraded to Ident 1 and so was out of action
- About to drive the finger in ice to the West Midlands bureau for identification when someone said, *“Lincolnshire claim to do electronic transmission of fingerprints, let’s try them.”*
- Scanned image of a lift from finger and e-mailed it via pnn to Lincolnshire bureau. Within 30 minutes loaded image onto Ident 1, identified it, triple checked and reported name of their burglar
- Identification was made in 30 minutes from 150 miles away

Acknowledgements

Jeevandra Sivarjah	University of Sheffield
Mick Carling	Lincolnshire Police
Lesley Allinson	University of Lincoln
Robert Green	Home Office PSU
Tony Lake	ACPO (Forensics Portfolio)

Further details, please contact:

admin@SceneBiometrics.com