Report on

Wireless LAN War Driving Survey 2016

Hong Kong

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This report is produced for the event SafeWiFi 2016 and can be downloaded from:

http://www.safewifi.hk

Organizers

Professional Information Security Association
(PISA)
專業資訊保安協會
http://www.pisa.org.hk

Hong Kong Wireless Technology Industry Association
(WTIA)
香港無線科技商會
http://www.hkwtia.org

Sponsor

通訊事務管理局
COMMUNICATIONS AUTHORITY
http://www.coms-auth.hk

Office of the Government Chief Information Officer
The Government of the Hong Kong Special Administrative Region
http://www.ogcio.gov.hk

Disclaimer

This report is to provide information on WLAN security status and risks in Hong Kong. It should not be used for malicious intent. Unauthorized Access to computer systems is an offense. The author takes no liability to any act of the user or damage caused in making use of this report.

The points made here are kept concise for the purpose of presentation. If you require details of the test and implementation, please refer to other technical references.

Report on Wireless LAN War Driving Survey 2016 Hong Kong - Editorial Board

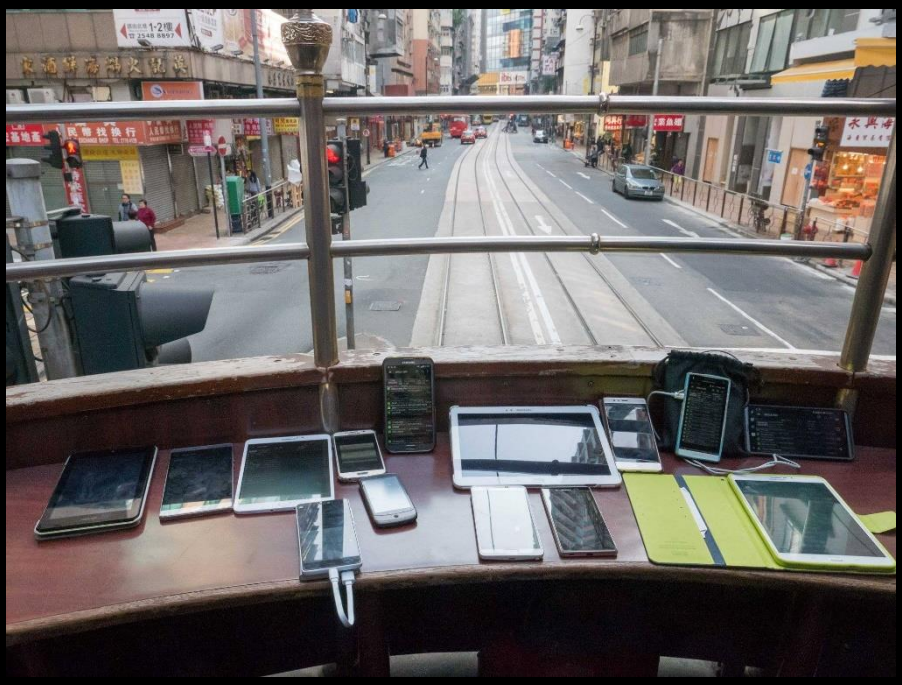
Mr. Roy Law

Acknowledgements

Name	Organization
Mr. Roy Law – Convenor	WTIA
Mr. Barry Ng	Office of the Government Chief Information Officer
Mr. Alan Ho	Valkyrie- X Security Research Group
Mr. Eric Fan	PISA
Mr. Frank Chow	PISA
Mr. Frankie Wong	PISA
Mr. Jim Shek	PISA
Ms. Joyce Fan	PISA
Mr. Mike Lo	PISA
Mr. Otto Lee	PISA
Mr. Paco Siu	MHD Security
Mr. Sang Young - Technical in charge	PISA / WTIA
Mr. Tony Wong	WTIA
Mr. Tony Tong	Evention Limited
Ms. Au Shun Yi	Hong Kong Institute of Vocational Education (Chai Wan)
Mr. Choi Kai San	Hong Kong Institute of Vocational Education (Chai Wan)
Mr. Ngan Tsz Him	Hong Kong Institute of Vocational Education (Chai Wan)

Photos

Wartraming 2016@18-Dec-2016



Wartraming 2016@18-Dec-2016

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Terms Used

WLAN	Wireless Local Area Network. There are five popular standards now: • 802.11a: using 5GHz, 54Mbps • 802.11b: using 2.4GHz, 11Mbps • 802.11g: using 2.4GHz, 54Mbps • 802.11n: using 2.4GHz or 5GHz, 300Mbps • 802.11ac: using 5GHz, 1.69Gbps
War Driving	Collecting wireless LAN information including network name, signal strength, location, and security settings by using a device capable of WLAN signal receiver and moving from one place to another.
GPS	GPS stands for Global Positioning System. It is a "constellation" of 24 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The GPS is owned and operated by the U.S. Department of Defense but is available for general use around the world.
AP	Access Point. A device that serves as a communication “hub” for wireless clients. In SME or home, it is also referred as Wi-Fi router.
MAC	Media Access Control address. The physical address of a Wireless LAN card.
SNR	Signal-to-Noise Ratio. A measurement of signal strength versus noise.
SSID	Service Set Identifier. The identifier name of each wireless LAN network. It is also referred as network name.
WEP	Wired Equivalent Privacy. An encryption protocol in using WLAN.
WPA	Wireless Protected Access. An improved encryption protocol over WEP in using WLAN.

WPA2	IEEE 802.11i Standard on Wireless LAN security improvement.
TKIP	Temporal Key Integrity Protocol. An encryption protocol in using WPA.
AES-CCMP	Advanced Encryption Standard - Counter Mode with Cipher Block Chaining Message Authentication Code Protocol. An encryption protocol in using WPA2.
WPS	Wi-Fi Protected Setup. It is a standard for user to setup up a secure wireless home network without understanding the details of security settings in a wireless LAN environment.

Executive Summary

In Dec 2016, the two associations **PISA** and **WTIA** jointly conducted the "War Driving 2016" field survey along the classic tramway of Hong Kong Island and Cheung Chau. In addition, we carried out the war driving for three (3) estates in year 2017. This survey is also part of the "SafeWiFi.hk" program. The objectives of this survey are to conduct a non-intrusive study on the status of Hong Kong WLAN security and arouse the public awareness in securing the use of Wi-Fi.

The field survey was conducted successfully with the help of volunteers engaged by two associations. The results were benchmarked against that of the previous studies conducted by PISA and WTIA since 2002 to plot the profile of Hong Kong Wi-Fi security development. The survey indicated that the adoption of secure WLAN keeps on increasing slightly.

The study was carried out in a non-intrusive and responsible way. It provides the abstracted view on the security status of WLANs in Hong Kong. The information of individual vulnerable AP was not disclosed.

PISA and **WTIA** share a common vision in promoting the use of wireless network in a productive and secure manner. They call for the public awareness of the problem. They would follow up the findings with educational programs to promote the adoption of Wi-Fi security strategies.

The Hong Kong WLAN Security Index 2016 is **71** which is same as last year.

Introduction

In 2002, a team of **PISA** Wi-Fi investigators performed the city's first "War Driving" study on the Wireless LAN (a.k.a Wi-Fi) Security Flaws in Hong Kong. It had aroused the public and corporations awareness to tighten their WLAN security loopholes. Since 2003, **PISA** and **WTIA** jointly conducted the annual "War Driving". The primary scope of test was extended to:

- the whole tram way, covering the business corridor of the HK Island

In Dec 2016, **PISA** and **WTIA** conducted the **15th "War Driving"** again to benchmark the improvement for the WLAN Security in Hong Kong. In addition, we conducted the "War Driving" at 3 types of estate in order to understand the security situation with respect to the characteristics of estates.

Since 2008, "Wireless LAN War Driving Survey" has become part of the program of "SafeWiFi.hk". More information about the "SafeWiFi.hk" program can be found in http://www.safewifi.hk.

Objectives of this Study

1. To study the current WLAN security status of Hong Kong and to benchmark the result with that of the previous year
2. To study the usage of encryption methods
3. To conduct a non-intrusive* information security study with responsible disclosure of information
4. To arouse the public awareness in Wi-Fi security and follow up with education programs
5. To observe if there is an interesting finding after collecting the information

** The study involved **neither sniffing of data nor jamming of network traffic**. The tool used was mainly for the discovery of wireless network broadcasted signals. No association with access points and no network connection were attempted during the war driving study and no data user data was captured. Every participant agreed and endorsed the Code of Ethics which is documented in the next section.*

Code of Ethics

The organizers, the reporters and all other participants agreed on the following points of the study to take care of the security and privacy issues.

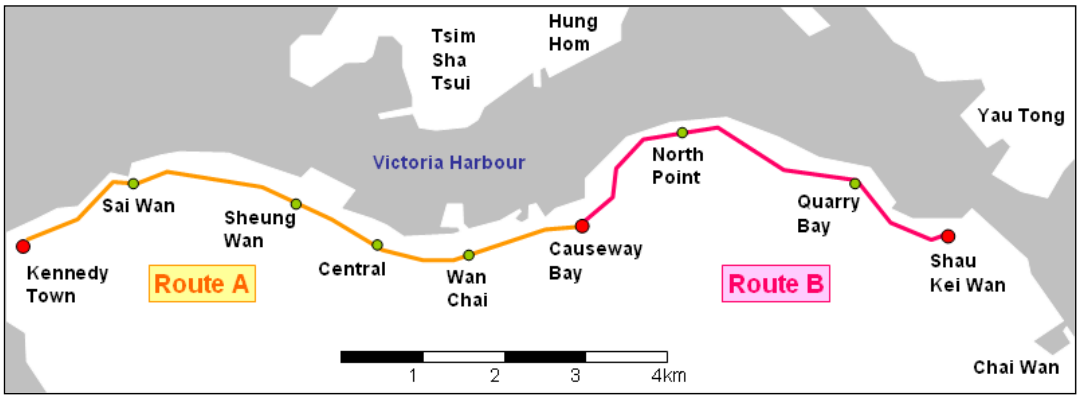
- Our objectives of the War Driving are to study the WLAN security status and compare it with the previous results, and to arouse the public awareness in WLAN security.
- We do not publicize the exact location and identity (e.g. SSID and MAC address) of any discovered AP. If such information appears in photos or other forms, it will be fully masked.
- We do not connect to the IP network of any insecure AP to further exploit its vulnerabilities.
- We do not interfere / jam any wireless traffic.
- We do not capture or collect any WLAN traffic payloads or data.
- We limit to the scope we state above only.

Methodology and Equipment

Tramway War Driving

- Tram is only available in a handful of cities around the world and tram riding is a popular activity of tourists in Hong Kong
- War Driving on a tram had been proved to be a very effective way because trams run at a moderate speed (30-50km/h) in the middle of the road, allowing a very good coverage of signals from the both sides of the road
- By War Driving on a tram, we targeted to benchmark the results with that of the war driving study conducted since year 2003 along the tramway from Kennedy Town to Shau Kei Wan. This route was equivalent to the whole business corridor of the Hong Kong Island

Details:	
Date:	18 Dec, 2016 (Sunday)
Time:	10 am – 2 pm
Equipments :	*Hardware:* • Android Tablet/Phone *Software:* • WigleWifi Wardriving for Android OS (https://play.google.com/store/apps/details?id=net.wigle.wigleandroid)
Route:	Tramway from Kennedy Town to Shau Kei Wan



Estates War Driving

This year, PISA and WTIA conducted the "War Driving" on three (3) estates in Hong Kong in June & July of 2017. The objective of this exercise is to identify if any significant deviation of encryption usage by comparing to the exercise we did by using Tram.

The demographic information of these estates is as follow:

Type	Demographic Information
Estate A	• Private Housing Estate • 61 Residential Towers • Total 12,698 apartment flats • Completion since 1977 • Middle-class population
Estate B	• Home Ownership Scheme • 12 Residential Blocks • Total 4,200 apartment flats • Completion since 1993
Estate C	• Public Housing Estate • 9 Residential Buildings • Total 3,129 apartment flats • Completion since 1963

Additional Activity

In addition to the regular tramway war-driving, a visit to the Island of Cheung Chau has been carried out in order to understand if there is any interesting observation. The demographic information of Cheung Chau is:

- Area: 2.44 km^2
- Population: 22,240 as of year 2011

Findings and Analysis – Tramway

Tramway War Driving 2016 Snapshots

Number of Access Points Captured	51,322
Access Points without using Encryption	8,374 (16.32%)
Access Points without securing the SSID *(include default SSID, SSID same as trailing hexadecimal of AP's MAC address, hotspots etc)*	10,072 (19.63%)

2016 Result Compared with Previous Years

The following table contains the result of whole tramway from year 2003 to year 2016.

Date of Test	Weather Condition	Number of Total Access Points	% of No Encryption	% of Insecure SSIDs
18 Dec 2016	Cloudy	51,322	16.32% ↑	19.63% ↓
6 Dec 2015	Cloudy	34,310	16.82% ↑	6.99% ↑
21 Dec 2014	Sunny	24,977	23.26% ↓	20.89% ↓
22 Dec 2013	Sunny	28,478	15.31% ↓	11.38% ↓
2 Dec 2012	Cloudy with a few rain patches	39,074	11.26% ↑	5.73% ↑
18 Dec 2011	Fine & Dry	16,618	12.12% ↑	9.09% ↑
5 Dec 2010	Sunny	16,462	13.64% ↑	13.40% ↓
26 Nov 2009	Sunny	15,753	15.50% ↑	11.57% ↑
9 Nov 2008	Trace Raining	7,388	19.26% ↑	20.41% ↑
4 Nov 2007	Sunny	6,662	27.50% ↑	30.29% ↑
15 Oct 2006	Occasional Raining	4,344	37.04% ↑	44.01% ↓
4 Dec 2005	Sunny	2,650	46.08% ↑	12.98% ↑

28 Nov 2004	Sunny	1,723	61.00% ↑	46.00% ↓
5 Oct 2003	Sunny	784	70.00%	43.00%

Legend

↑: Improved from security point of view, compare with previous year

↓: Unsatisfied from security point of view, compare with previous year

Highlights

1. The number of detectable deployment along the tramway, comparing with last year, increased by 49.58%. The primary reason is that the Android Tablet is more powerful than those one used in year 2015. In addition, it was observed that a lot of new Access Point deployed with dual band (2.4G & 5G), two SSIDs are broadcasted. As a result, the number of detectable access points are increasing.
2. The percentage of APs with encryption turned on improved slightly.
3. The percentage of APs with SSID secured dropped back to nearly the figures recorded in year 2014. It was observed that a lot of new deployed access points are using the default SSID.

Encryption Usages

The figures below cover the encryption usages break down comparing with last few years. Before 2008, we use Netstumbler as the war-driving tool which cannot distinguish between WEP, WPA and WPA2. Therefore, the comparison is starting from year 2008 with the introduction of new tools Vistumbler. Since 2014, the WigleWiFi for Android is used.

WEP, WPA and WPA2 Usage (expressed in %) Distribution

Year	No Encryption	WEP	WPA	WPA2
2016	16.32	3.10	31.69	48.89
2015	16.82	5.84	33.81	43.53
2014	23.26	5.75	33.38	37.61
2013	15.31	13.27	13.26	58.16
2012	11.26	15.47	20.33	52.94
2011	12.12	24.66	19.76	43.46
2010	13.64	34.05	21.41	30.9
2009	15.50	45.01	19.89	19.6
2008	22.86	43.18	26.34	7.62

The usages of WEP, WPA, and WPA2 are 5.84%, 33.81% and 43.53% in year 2015 while the

usages of these are 3.10%, 31.69% and 48.89% in year 2016. The key observation in this area is the usage of WEP is keeping dropping. It could be the phenomena of routers were replaced and the suggested encryption of new routers is configured to automatic mode (i.e. both WPA and WPA2 simultaneously). As a result, the percentage of using WPA is still keeping at around 30. The observation is close to last year's survey.

TKIP and AES Usage (expressed in %) Distribution

Year	No Encryption	WEP	TKIP	AES
2016	16.32	3.10	25.57	55.01
2015	16.82	5.84	26.79	50.55
2014	23.26	5.75	28.10	42.89
2013	15.31	13.27	12.03	59.39
2012	11.26	15.47	18.39	54.88
2011	12.12	24.66	29.49	33.73
2010	13.64	34.05	27.76	24.55
2009	15.50	45.01	32.93	6.56
2008	22.86	43.18	29.17	4.79

From another point of view, the adoption of more secure encryption methods (i.e. AES) increases from 50.55% to 55.01%.

WPS Usage

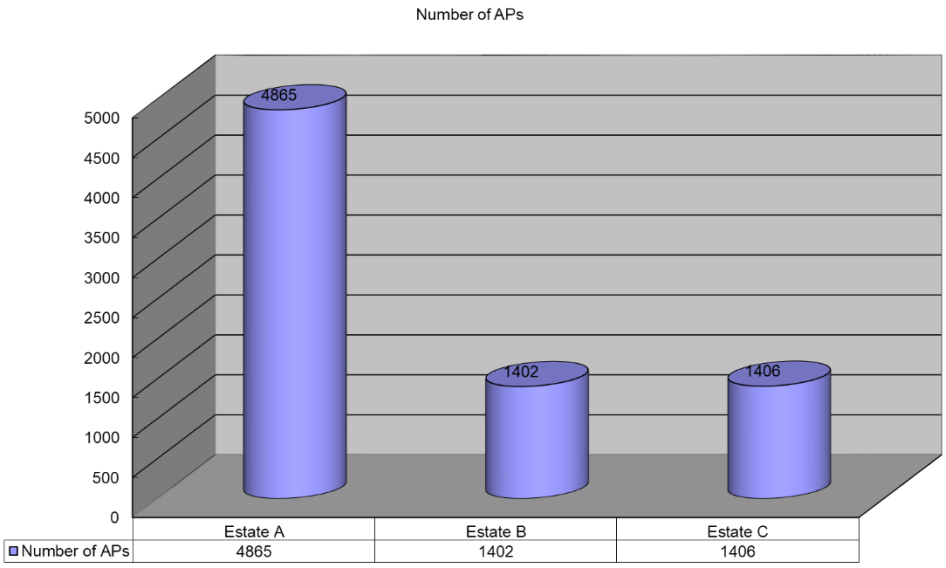
Wi-Fi Protected Setup (WPS) is a computing standard that attempts to allow easy establishment of a secure wireless home network. A major security flaw was revealed in December 2011 that affects wireless routers with the WPS feature. In this year, we also aim to identify the potential risk of WPS by also discovering the amount of WPS turn-on on the discovered AP.

	2012	2013	2014	2015	2016
WPS Usage	39.82%	34.67%	34.08%	28.82%	33.02%

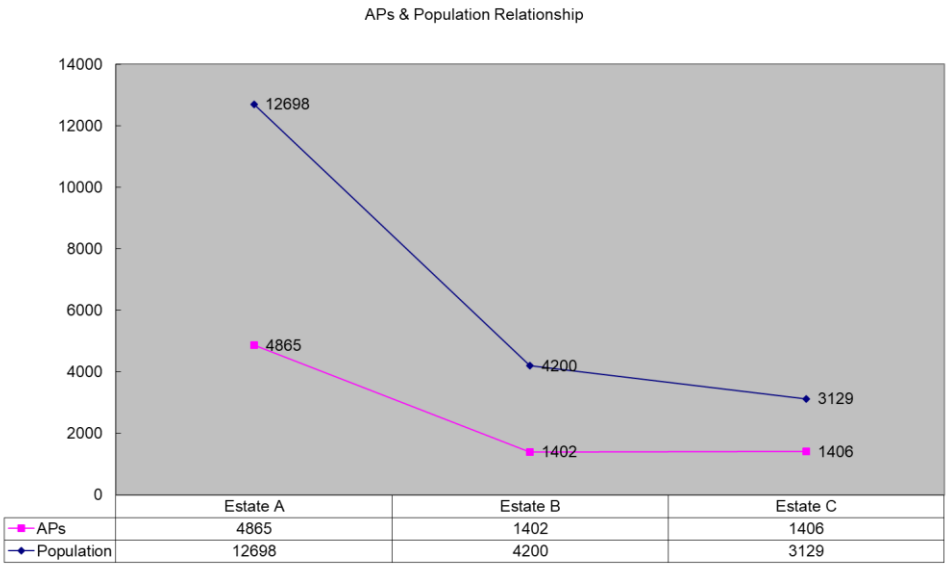
It is observed that there is the adoption of disable WPS feature is dropping back to 2014.

Findings and Analysis – Estates

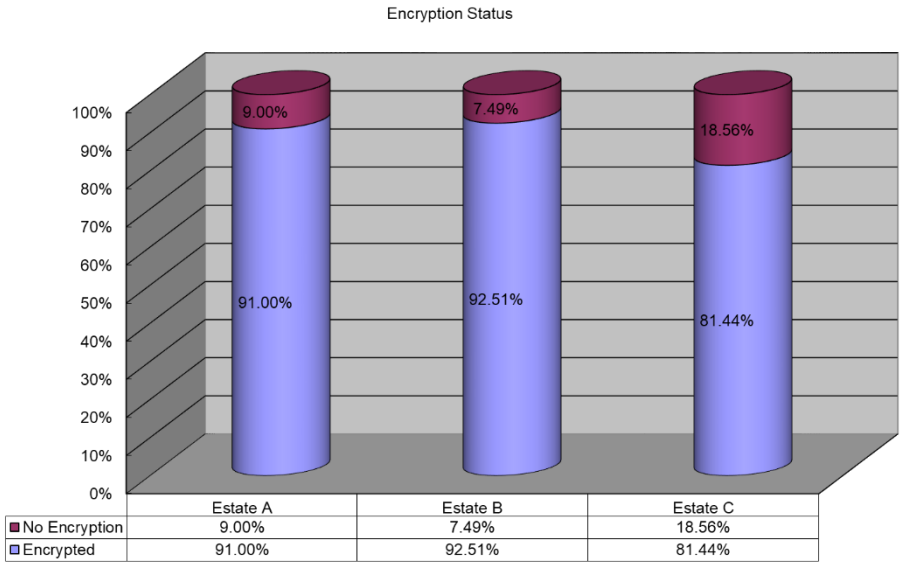
1. Number of Unique AP Captured



2. Relationship between population and number of discovered Access Points

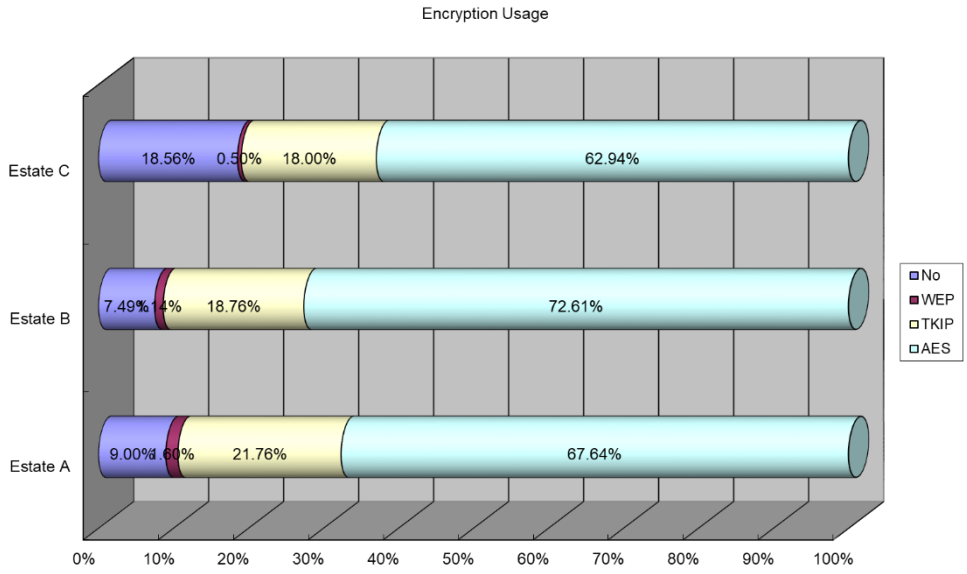


3. Encryption Status



	Estate A	Estate B	Estate C
No Encryption	9.00%	7.49%	18.56%
Encrypted	91.00%	92.51%	81.44%

4. Encryption Usage



5. Comparison with Previous Years

We did a similar exercise since year 2010. Below is the comparison in areas including the Number of Access Points, Encryption Status, and Encryption Usage.

5.1 Number of Unique Access Points Captured

	2010	2011	2012	2013	2014	2015	2016
Estate A	3261	2626	3364	3072	4224	3206	4865
Estate B	1417	1952	2838	1315	2127	4709	1402
Estate C	382	565	1057	1308	1990	11770	1406

5.2 Encryption Status (No Encryption)

	2010	2011	2012	2013	2014	2015	2016	Remarks
Estate A	6.75%	9.94%	7.22%	7.55%	9.99%	11.10%	9.00%	
Estate B	9.95%	7.07%	4.90%	5.78%	3.29%	13.77%	7.49%	
Estate C	10.99%	11.50%	5.77%	11.09%	13.02%	15.66%	18.56%	

5.3 Encryption Usage

	2010	2011	2012	2013	2014	2015	2016	Remarks
Estate A								
No	6.75%	9.94%	7.22%	7.55%	9.99%	11.10%	9.00%	Improved ↑
WEP	34.38%	24.89%	16.56%	8.79%	5.28%	4.71%	1.60%	Improved ↑
TKIP	15.37%	15.87%	13.91%	33.59%	30.66%	26.29%	21.76%	Improved ↑
AES	43.5%	49.30%	62.31%	50.07%	54.07%	57.90%	67.64%	Improved ↑
Estate B								
No	9.95%	7.07%	4.90%	5.78%	3.29%	13.77%	7.49%	Improved ↑
WEP	34.02%	26.54%	21.21%	9.66%	4.51%	4.03%	1.14%	Improved ↑
TKIP	20.32%	17.73%	17.94%	35.21%	35.40%	25.06%	18.76%	Improved ↑
AES	35.71%	48.66%	55.95%	49.35%	56.80%	57.14%	72.61%	Improved ↑
Estate C								
No	10.99%	11.50%	5.77%	11.09%	13.02%	15.66%	18.56%	Degraded ↓
WEP	34.55%	20.01%	18.92%	12.61%	7.49%	3.62%	0.50%	Improved ↑
TKIP	21.21%	16.80%	21.00%	18.27%	30.60%	25.24%	18.00%	Improved ↑

AES	33.25%	51.69%	54.31%	58.03%	48.89%	55.48%	62.94%	Improved ↑

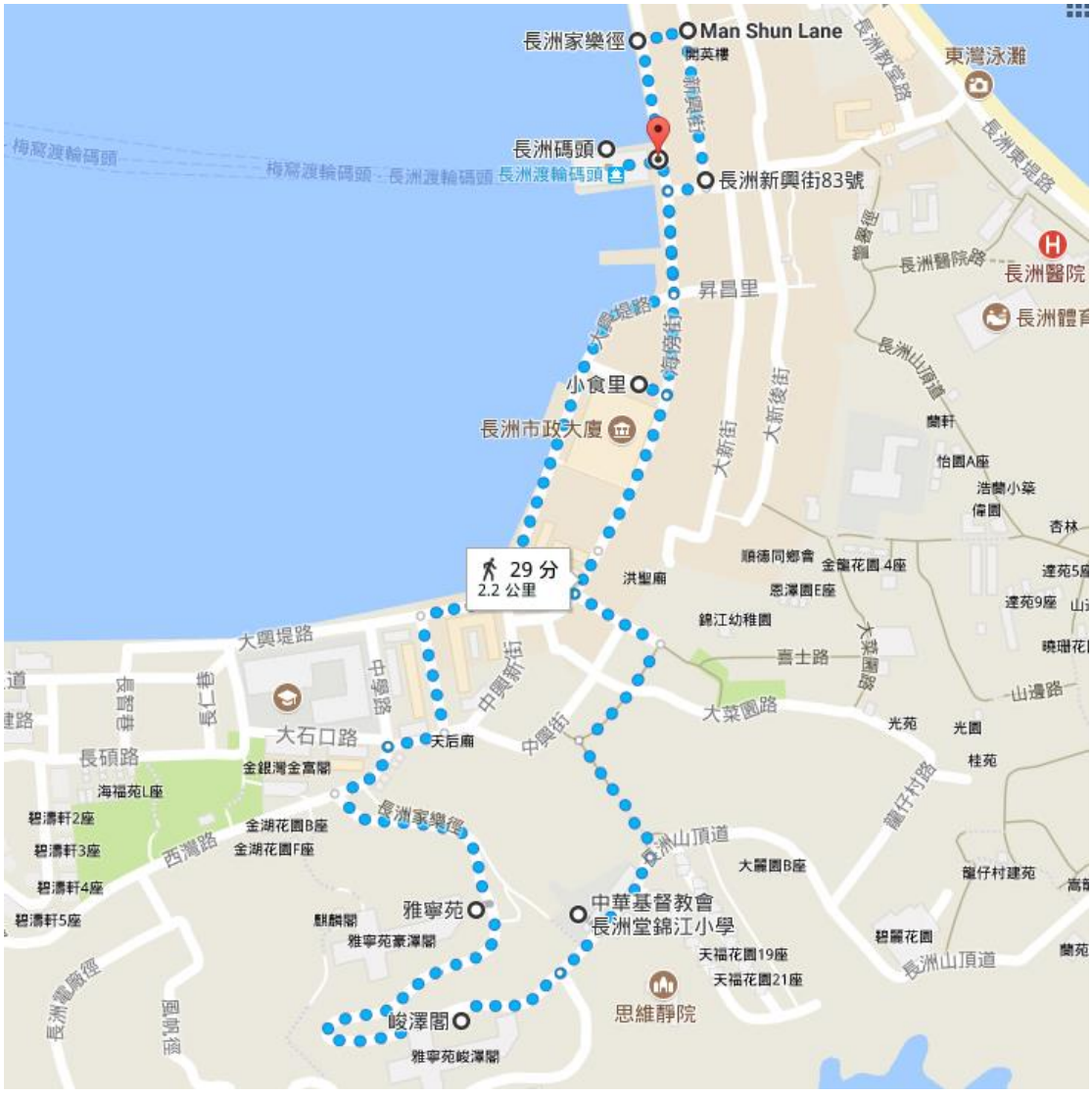
In terms of encryption, the AES would be the best choice at this moment. We expect the usage of AES is keeping on increasing while the usages of WEP and TKIP are dropping. For this year's survey, the use of AES in these estates is over 60% of the total APs. In addition, the use of WEP is dropping to under 2%. It shows that the adoption of secure Wi-Fi networks, particular by home users, are improving in year 2016.

Findings and Analysis – Cheung Chau

The Island of Cheung Chau is 10 kilometres southwest of Hong Kong Island and had a population of around 25,000. War-driving team took a few hours walking under sunny, hot and over 75% of relative humidity day on 24 Jun 2017 to collect the Wireless LAN security status in there.

Below are the activity photos on 24 Jun 2017 in the Island of Cheung Chau:

Route at Cheung Chau



War Driving at Cheung Chau Snapshots

Number of Access Points Captured	2,146
Access Points without using Encryption	164 (7.64%)
Access Points without securing the SSID *(include default SSID, SSID same as trailing hexadecimal of AP's MAC address, hotspots etc)*	229 (10.67%)
WEP, WPA and WPA2 Usage Distribution	
WEP	11.56%
WPA	28.61%
WPA2	52.19%
TKIP and AES Usage Distribution	
TKIP	22.51%
AES	58.29%
WPS Usage	34.61%

Highlights:

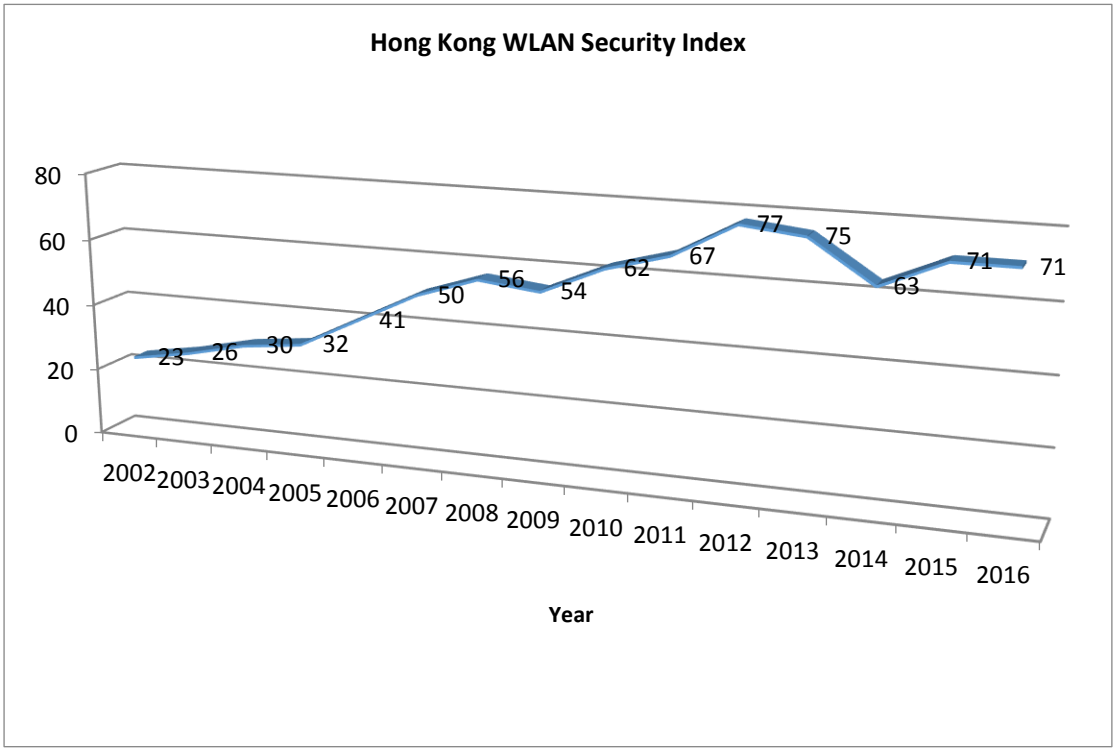
1. The adoption of secure encryption method (using AES) is 58.29% which is a good indication from security perspective.
2. The percentage of using WPS is consistency to the Tramway figures. They are around 34%.

Hong Kong WLAN Security Index

The Hong Kong WLAN Security Index [香港無線網絡安全指數] is compiled by the Hong Kong Wireless Technology Industry Association (WTIA) and Professional Information Security Association (PISA), for analyzing data collected in War Driving surveys over the years.

This index takes into account the factors of the overall public awareness of encryption applied in Hong Kong, the best practice in securing the WLAN infrastructure and the technologies adopted. Every year, we review the weighting to these three factors by referring if any vulnerability discovered.

PISA and WTIA maintain this Index to keep tracking on the implementation status in WLAN security in Hong Kong. Below is the graph representing the index from year 2002 to 2016:



The index is same as last, we are looking forward to seeing the improvement in next year.

Conclusion

Tramway War Driving

- This year, data collected from Wigle using Android Phone/Tablet.
- The number of discovered access points is increased by nearly 50%. It was observed that new deployed access point with dual band enabled (both 2.4G and 5G). As a result, one more SSID is discovered.
- The use of WEP maintains at around 3%. This is a good sign and we shall keep on observing it if this figure is going to saturate.
- **The percentage of Access Points with encryption enabled is around 84 percentages, a slight improvement is observed.**
- Large portion of APs are open in year 2015 and 2016, due to the large number of AP Hotspots which provide no encryption.
- **The percentage of AP with WPS enabled is rising from 28.82 to 33.02 percentages**. There is known security vulnerability in WPS. With more and more new Access Points deployed, this figure is increased too. It still shows that around **most of WLANs are subjected to this attack** and lack of awareness in this area.

Encryption Usages

- In recent year, WEP cracking methods are enhanced. It allows an intruder to penetrate to a WLAN using WEP cracking within 10 minutes of time. In our study, only around **3% of WLANs are still using WEP**.
- The adoption of WPA/WPA2 is improved **over 80%**. It shows the adoption of more secure encryption methods is increasing.
- In year 2008, there is a way to crack WPA using TKIP as an encryption algorithm. In our study, 25.57% of WLANs are using TKIP although the figure decreased.
- WEP is dropping significantly while TKIP is increasing drastically. It may be due to the case that the old Access Points were replaced but configured with **automatic selection of TKIP and CCMP (AES)**. We suggest enforcing the use of CCMP (AES) only.
- The adoption of more secure encryption methods – AES is increased **from 50.55% to 55.01%**. Improvement is indicated but it is not the best in our 15 year's study.

Estate War Driving

- Number of discovered APs should directly relate to the number of population.
- The percentage of using AES encryption is over 60% this year in our sampled three estates. And this figure is keeping on increasing.

WPS Usage

- **The percentage of AP with WPS enabled is around 34 percentages**. There is known security vulnerability in WPS. It has improvement but it still shows that large **WLANs are subjected to this attack** in this area.

Hong Kong WLAN Security Index

- The Hong Kong WLAN Security Index of 2016 is 71 which is same as the large year's survey.

Overall Observation

- The percentage of "no encryption" is maintaining over 15% this year. It seems to be that the security adoption in Wi-Fi networks is worse than last year. However, large portion of the non-encrypted Wi-Fi are well-known hotspot. By eliminating the factor of this and referring to the WLAN security index calculation, the WLAN security is maintained.