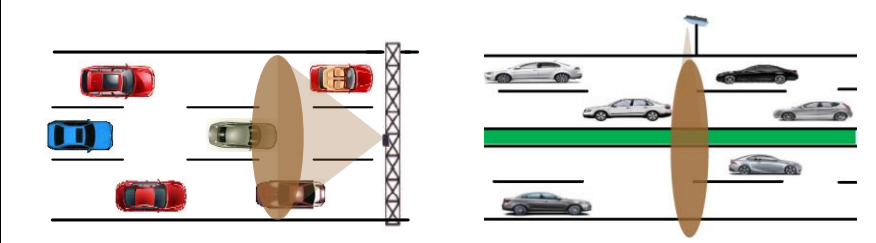
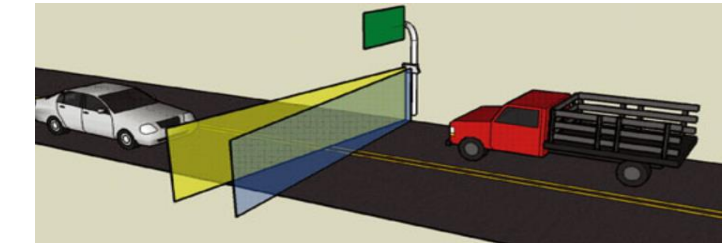
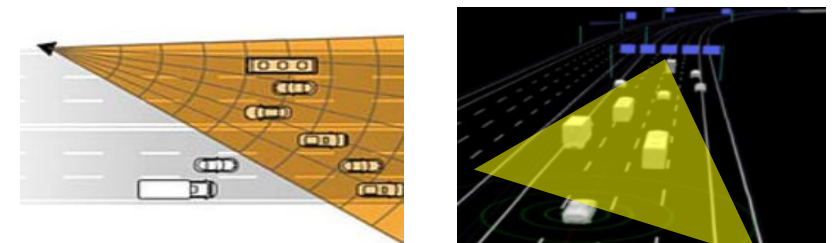


	單波束雷達	雙波束雷達	多波束雷達
產品比較說明			
代表廠商 / 產品	均利科技	Wavetronix SS 126	SMARTMICRO
生產地	軟、硬體全台灣設計生產製造。客製化彈性高。	美國產品，台灣為代理進口，客製化修改困難。	德國製造，台灣為代理進口，客製化修改困難。
後勤維修	7日內維修完畢，若無法及時修復，將提供新品替換。	維修時間長，缺乏即時對應彈性	維修時間長，缺乏即時對應彈性
安裝方式	依需求，可路側垂直道路安裝或正向安裝架設容易。	路側，垂直斷面車道安裝偵測。	主要正向安裝、路側需斜打平行道路，安裝點不易。
偵測車道數	側向垂直道路可同時偵測8~10車道。	側向垂直道路可同時偵測8~10車道。	斜打、正打必需平行道路同時偵測距離夠遠(>100米)才能追蹤多車道，斜打至多3~4車道。更多車道需置中，易被建物、路樹遮擋。同時多車道置中往往要設置在龍門架安裝點不易。
偵測距離	側打，偵測距離大於80米。	側打，偵測距離大於80米。	一般直線距離大於100米，但前方有較大的盲區距離。
盲區距離	受限頻寬。後退距離約1.8米，但架設高度拉高或立後退桿可改善。	受限頻寬。後退距離約1.8米，但架設高度拉高或立後退桿可改善。	多車道追蹤時，多波束偵測需平行車道夠遠，方能分辨各車道，同時也導致近端盲區相對大，超過10米以上的距離範圍。
實測速度準確率	速度準確度 $\geq 85\%$ 速度低於30km/hr，誤差變大。	速度準確度 $\geq 90\%$ 速度低於30km/hr，誤差變大，不給資料。	速度準確度 $\geq 90\%$ 速度低於30km/hr，誤差變大。
實測流量準確率	流量準確度 $\geq 90\%$ 速度低於30km/hr，誤差變大。	流量準確度 $\geq 90\%$ 速度低於30km/hr，誤差變大，不給資料。	流量準確度 $\geq 90\%$ 速度低於30km/hr，誤差變大。
價格比較	導入標案成本低。	導入標案成本高，但價格低於多波束產品。	導入標案成本很高。
CP值	CP值高。 1、正常情況平均流量/速度能達到85~90%精度。 2、多車道安裝限制小，路側、正向皆可。 3、國產自製設計，價格低。 4、速度低於30km/hr或壅塞時，流量與速度精度，一樣受物理現象影響無法達成預期精度。	CP值中。 1、正常情況下平均流量/速度能達到>90%精度。 2、多車道安裝限制小，宜斷面側打。但雙雷達觸動往往受限環境與車種影響，並非每部車車速都能獲得正確精度量測。且雙雷達不適宜正向安裝。 3、價格高。 4、速度低於30km/hr或壅塞時，流量與速度精度，一樣受物理現象影響無法達成預期精度。	CP值低。 1、正常情況下平均流量/速度能達到>90%精度。 2、多車道安裝限制大，無法垂直斷面側打，需盡量水平車道，且道路需要夠遠，夠直。 3、價格貴。 4、速度低於30km/hr或壅塞，流量與速度精度，一樣受物理現象影響無法達成預期精度。
其他應用範圍	觸動警示、安防電子圍籬、水位高度、應用...等。廣佈應用容易。	注重於交通分析資料蒐集。價格因素，不易廣佈於其他應用領域。	著重於交通管理偵測目的，成本價格高，不易廣佈於其他應用領域。

結論：

無論單雷達、雙雷達或多波束雷達，都可能發生在大車過多、車流混亂、雍塞、車外型特殊、大型拖拉、蛇行、跨車道...等因素，都有可能造成任何形式的雷達天線多重觸動或僅單次觸動造成偵測演算有顯著誤差，尤其在車速上甚至有很大誤差。因此只有在正常的環境下（或下述ss-126定義的Nominal Condition）各種波束型態的雷達偵測器，精度才可能提高。

結論：

基於上述單波束雷達、雙雷達、多波束雷達各項指標比較，綜整如下三點結論。

1. 單雷達在台灣各地早已通過嚴謹且完整的驗證，在正常的情況下，單波束雷達即可達到一般業管規格要求，而目前許多標規中只提雙雷達、多波束雷達兩項產品而忽略單雷達的優勢，有失公允。
2. 單波束雷達產品效能既可達到需求規格，同時是台灣本土化生產設計製造的雷達產品具備有：
第一，價格競爭力強，性價比高，第二，保固維修快速方便，第三，性能提升，更具實效性。
3. 政府積極培植國內本土化生產製造企業與產品，既然國內本土廠商所生產製造的雷達可以達到標規要求，單雷達產品應具備公平參與投標競爭的機會。
4. 另無論單雷達或雙雷達或多波束都可能發生在大車過多、車流雍塞、車外型特殊／大型拖拉、蛇行／跨車道等都有可能造成任何雷達天線遮擋、多重觸動或僅單次觸動造成偵測演算有顯著誤差，尤其在車速精度上甚至有很大誤差，因此只有在正常定義的環境下（或下述ss-126定義的Nominal Condition）雙波束或多波束精度或可較單波束雷達稍高。如以性價比來看單雷達仍然是最佳選擇。
5. 上述說明可提供給業主或驗收單位參考使用，另附上SS-126 Bid Specification 如附件一供參考，並擷取附件內容有關SS-126流量與速度精度驗測法則必需滿足Nominal Condition的定義綜整說明如下：

一、Nominal Condition: 有關流量精度驗測

- Nominal conditions exist when 1.average speeds are greater than 10 mph (16 kph) in every lane; when 2.there is less than 20% truck traffic per lane when 3. at least 50 cars per lane are counted in the interval.
- The percentage of missed detection and the percentage of false detections for each lane shall not exceed 15% during nominal conditions.

→所謂名目標準定義是1.平均速度大於16km/h, 2.大車每車道不能超過20% 3.每車道需大於50部車的通過.

滿足上述條件定義ss-126驗收才能達成斷面流量精度在95%以內。而每車道精度在90%內,每個車道丟車及錯誤的偵測不應大於15%,換句話說每車道的流量精度不能低於85%,這或許就是台灣驗收標準的由來可參考。

二、速度精度

Average speed data shall be accurate to within 3 mph (5 kph) for any direction of travel when there are more than five cars per lane in an interval. Average speed data for any individual lane shall be accurate to within 3 mph (5 kph) when there are more than five cars per lane in an interval.

平均速度精度在斷面是5KM/H,在每車道亦是5KM/H,同時每個車道必須超過五部車以上之平均

The RVSD shall provide per-vehicle speed measurements on 95% of vehicles that are not occluded by other vehicles or by barriers. The RVSD shall provide per-vehicle speed measurements in which 90% of the measurements are within 5 mph (8 kph).

對每個單車速度並未定義精度,僅說明在沒有阻擋或圍籬情況下有95%機率可提供量測資訊,在速度低於8KM/H會僅有90%能量測到速度資訊。

上述描述往往會誤導單車精度可達95%這是不對的,因此我認定即便SS-126也不可能達到95%精度,甚至有時量測不出資料的原因。

附件一：

Wavetronix SmartSensor HD SS-126 Bid Specification

1. General. This item shall govern the purchase of aboveground radar vehicle sensing devices (RVSD) equivalent to the Wavetronix SmartSensor™ HD.

An RVSD detects vehicles by transmitting electromagnetic radar signals through the air. The signals bounce off vehicles in their paths and part of the signal is returned to the RVSD. The returned signals are then processed to determine traffic parameters. RVSDs are not affected by normal weather and environmental conditions such as rain, wind, snow, dust, etc. They also do not require cleaning and can maintain performance over a wide range of ambient temperatures. RVSDs provide a non-intrusive means of detecting traffic because they can be installed at the side of a roadway. This property not only makes them safer to install but also more cost effective than sensors that require roadway modifications or placement.

2. Measured Quantities.

- The RVSD shall provide volume, average speed, occupancy, classification counts, 85th percentile speed, average headway, average gap, speed bin counts and direction counts for user-configurable time intervals for up to 22 lanes of traffic.
- The RVSD shall provide up to eight length-based classification bins.
- The RVSD shall provide up to 15 speed bins.
- The RVSD shall provide speed, length, class, lane assignment, and range data for each vehicle detection.
- The RVSD shall provide presence data for up to 22 lanes of traffic.

3. Detectable Area.

3.1. Maximum Lanes. The RVSD shall be able to detect and report information from up to 22 lanes.

3.2. Detection Range. The RVSD shall be able to detect and report information in lanes with boundaries as close

as 6 ft. (1.8 m) from the base of the pole on which the RVSD is mounted. The RVSD shall be able to detect and report information in lanes located with the far boundary at 250 ft. (76.2 m) from the base of the pole on which the RVSD is mounted. The RVSD shall be able to simultaneously detect and report information from a lane located at the minimum offset and from a lane located at the maximum range.

3.3. Lane Size and Spacing. The RVSD shall allow any spacing of traffic lanes positioned from the minimum offset to the maximum range. Gore and unequally sized or spaced lanes shall be handled so that detections from the lanes meet all performance specifications. Not all roadways have lanes that lie on evenly spaced intervals. Some roadways have gore, odd-sized medians and unequal lane sizes. An RVSD should be able to handle all these cases.

3.4. Barrier Performance. The RVSD shall detect vehicles with the specified accuracy in lanes that are adjacent to a barrier when 50% of a sedan is visible over the barrier from the point of view of the RVSD.

4. Performance.

4.1. Volume Accuracy. The volume data shall be within 5% of truth for a direction of travel during nominal conditions. Individual lane volume data shall be within 10% of truth during nominal conditions. The percentage of missed detection and the percentage of false detections for each lane shall not exceed 15% during nominal conditions. Nominal conditions exist when average speeds are greater than 10 mph (16 kph) in every lane; when there is less than 20% truck traffic per lane when at least 50 cars per lane are counted in the interval. The RVSD shall detect a minimum separation of 5.5 ft. (1.67 m) between two vehicles depending on vehicle speed and range.

4.2. Speed Accuracy. Average speed data shall be accurate to within 3 mph (5 kph) for any direction of travel when there are more than five cars per lane in an interval. Average speed data for any individual lane shall be accurate to within 3 mph (5 kph) when there are more than five cars per lane in an interval.

The RVSD shall provide per-vehicle speed

- measurements on 95% of vehicles that are not occluded
- by other vehicles or by barriers. The RVSD shall provide
- per-vehicle speed measurements in which 90% of the
- measurements are within 5 mph (8 kph).

The RVSD shall measure speed using a dual-radar speed trap that calculates the time delay between two different radar beams.

The dual-radar time delay method of calculating speed produces accurate per-vehicle speeds which enable accurate length measurements, classification, 85th percentile speed measurements and responsive average speed measurements. In contrast, algorithms that derive the speed from presence measurements or vehicle durations have been shown to produce significant biases in the speed measurements especially during congestion.

- 4.3. **Occupancy Accuracy.** Occupancy data shall be within 10% of truth for any direction of travel on a roadway during nominal conditions. For example, if the true occupancy in a lane is 20%, then the measured occupancy shall be between 18% and 22%. Individual lane occupancy shall be within 20% during nominal conditions. Nominal conditions exist when true occupancy is less than 30%, without merging traffic; when average speeds are greater than 10 mph (16 kph) in every lane; and when there is less than 20% truck traffic per lane.
- 4.4 **Classification Accuracy.** The RVSD shall correctly determine classification for 80% of detected vehicles when the classification bins are at least 10 ft. (3 m) wide and occupancy of all lanes is below 30%.