参考資料2

UWBレーダ作業班（第３回）に対して提出された意見及び推進側の考え方
ー意見２(FSS)に関する参考資料集－

古河電気工業株式会社
青柳　靖

［概要］

本文章は、固定衛星業務（FSS；Fix Satellite Service）に関する意見への回答を示す根拠となる参考資料を提供するものである。

［目次］

１．エアバッグ普及率について

図１にエアバッグの普及率を示す。エアバッグは、1995 年から急速に新車装着率が伸び、1997 年までの３ 年間でほぼ9割に達している。その後も新車装着率は伸び、100%に漸近している。保有台数ベースの普及率は、1997 年から年率約 8%でリニアに伸びている。このように、エアバッグは安全規制の強化も影響して、非常に急峻に装着が進んだ特異例と考えられる。

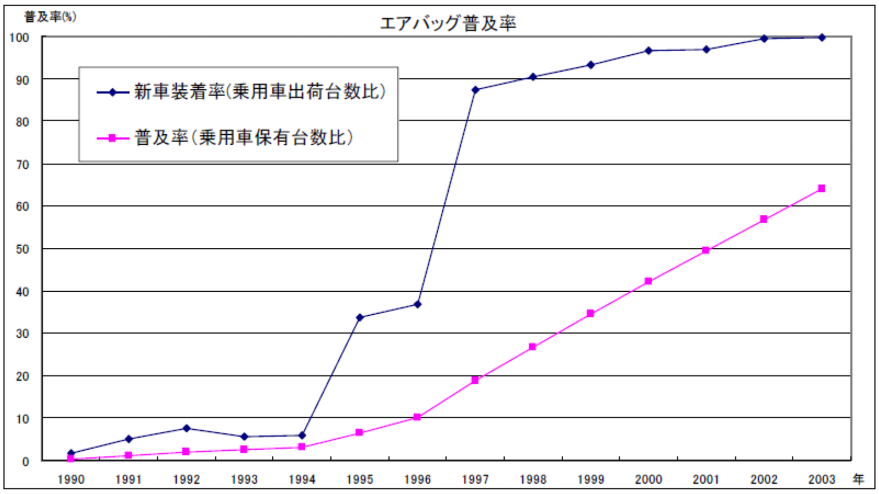

図１．エアバッグ普及率

（データ出典: 日本自動車工業会、財団法人自動車検査登録協力）

さらに、エアバッグは単一の方式であるため、100%の普及＝同一方式となるが、SRR装置の場合、周辺監視センサが100%普及したとしてもそのテクノロジは、画像、超音波、レーザ、ミリ波などの他の選択肢があり、準ミリ波が100%に達する可能性は低いと考えられる。このような理由から、ITU-R　TG1/8では以下のような各テクノロジ毎の普及予測を立てている。我々推進側としては、この数値を提示させていただき、検討の根拠としていただきたいと考えている。

表２．ITU-R TG1/8 における周辺監視センサの種別普及予測

Technology	Technology penetration (%)		
	Europe/2013	Europe/2030	E.g. USA/2030
24 GHz UWB SRR sensors	7	0	40
79 GHz UWB SRR sensors	1	55	0
Narrow-band SRR sensors (e.g. 24.00-24.25 GHz band)	20	10	10
Infrared and ultrasonic sensors	15	15	15
Camera based sensors	2	10	10
Vehicles with no short-range　sensors at all	55	10	25

２．自動車保有台数推移予測

参考文献によれば、2002 年時において、保有台数時乗用車比率＝5450 万台／（1760 万台＋5450 万台）×100＝75.5%となっている。

出展："平成１６年度　第１回地球温暖化対策技術検討会参考資料 4"、環境省地球環境局(2004 年 4 月)

http://www.env.go.jp/earth/gijyutsu_k/16_01/ref_04.pdf

１．自動車保有台数見通し

【乗用車保有台数実績、販売台数実績、保有台数見通し】

○２０００年保有台数実績　：５，２５０万台(出典：自動車検査登録協会)
　　　　　　販売台数実績　：　　４２６万台(出典：日本自動車工業会)
○２００２年保有台数実績　：５，４５０万台(出典：自動車検査登録協会)
　　　　　　販売台数実績　：　　４５３万台(出典：日本自動車工業会)

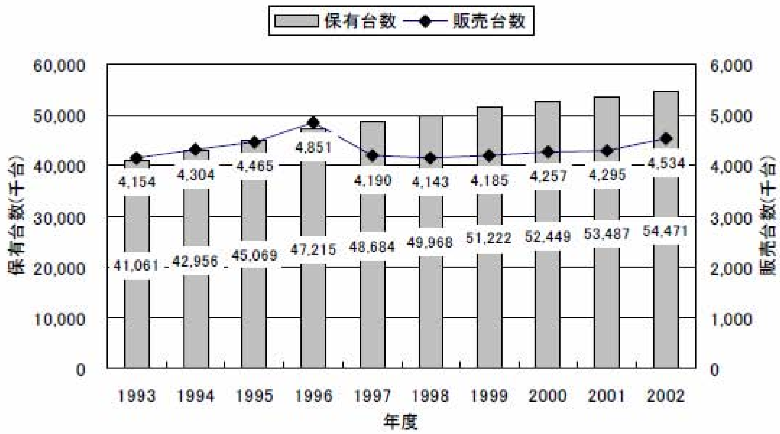

図１　乗用車保有台数、販売台数推移

○２０３０年保有台数見通し：６，２００万台(出典：資源エネルギー庁予測)

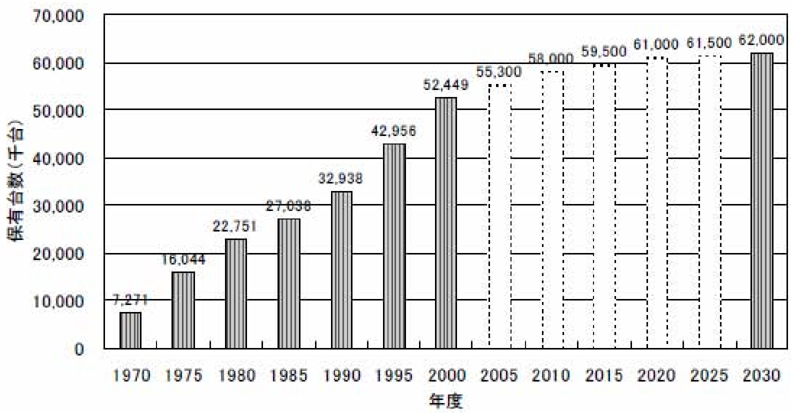

図２　乗用車保有台数見通し

【トラック・バス保有台数実績、販売台数実績、保有台数見通し】

○２０００年保有台数実績　：１，８３０万台(出典：自動車検査登録協会)
　　　　　　販売台数実績　：　　１７２万台(出典：日本自動車工業会)

○２００２年保有台数実績　：１，７６０万台(出典：自動車検査登録協会)
　　　　　　販売台数実績　：　　１３３万台(出典：日本自動車工業会)

○保有台数、販売台数とも減少傾向にある。

○２００２年におけるバスの保有台数、販売台数は1.3%(保有台数２３万３千台、販売台数１万７千台）程度

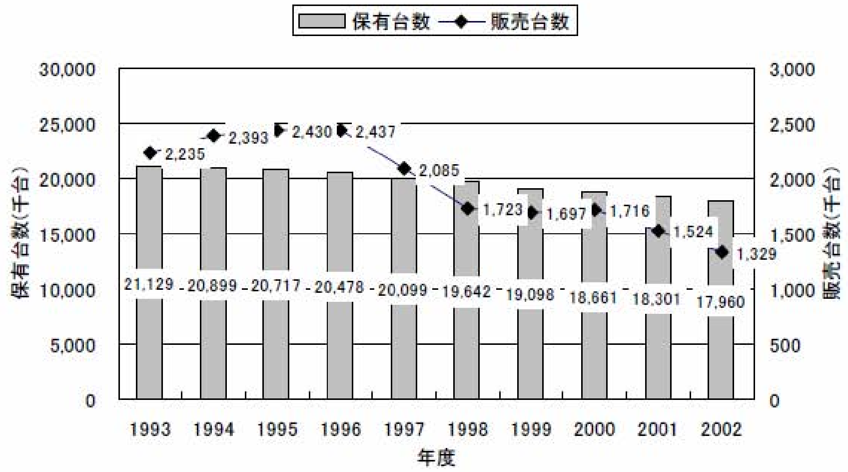

図３　トラック・バス保有台数、販売台数推移

○２０３０年保有台数見通し：２０００年から１６％減（約１，５７０万台）
（資料：国土交通省「交通需要推計について(H14.6.24)」より推計）

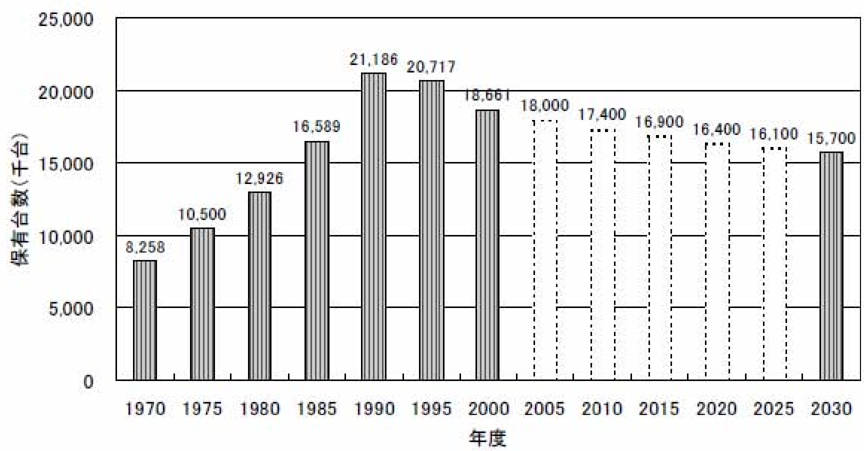

図４　トラック・バス保有台数見通し

３．ITU　TG1/8 における FSS 干渉検討

出展： Document 1-8/TEMP/214-E “STUDIES RELATED TO THE IMPACT OF DEVICES USING ULTRA-WIDEBAND TECHNOLOGY on SYSTEMS OPERATING WITHIN the FIXED-SATELLITE Service”より。

A3.2 UWB interference into FSS uplinks

This section summarizes different studies dealing with the uplink case that have been submitted to TG 1/8. All studies were based on the GSO satellite based simplified summation methodology to calculate the aggregate interference and used the FSS protection criterion (*I*/*N* = –20 dB) given in Recommendation **ITU-R S.1432.**

This methodology is based on the calculation of the interference by aggregating the emission of the UWB devices located in the satellite receive antenna beam. The nature of the interference coming from UWB devices is assumed to be noise-like.

A number of studies were performed using a UWB emission level of –41.3 dBm/MHz, and have been conducted in the frequency range of 6 GHz and 28 GHz considering free space propagation.

Study	Satellite assumptions	UWB assumptions	Maximum density of active UWB devices for I/N = –20 dB protection criterion
Study 1 8/14/30 GHz uplink	T = 500 K Global beam Ant. gain $G_{sat} \approx 10 \log (4\pi r^2/s)$	100% outdoor Uniformly distributed Free-space loss.	8 active UWB/km² @ 8 GHz 2 551 active UWB/km² @ 14 GHz 11 715 active UWB/ km² @ 30 GHz
Study 7 28 GHz uplink	T = 728 K Zone beam (N America) Satellite Ant. Gain (G_{SAT}) = 46.4 dBi Clear air loss = 0.5 dB	100% outdoor Uniformly distributed Free-space loss.	152 480 000 UWB devices over the beam (equivalent to approx 11 devices per km² over 15m km²)

The results of the various studies indicate that the aggregate interference into the satellite receiver is unlikely to be problematic for a protection criterion of I/N = -20 dB and a UWB device EIRP density of -41.3 dBm/MHz.

A3.3 UWB interference into FSS downlinks

TG 1/8 considered a number of studies that had addressed interference from UWB devices into FSS downlinks. This section summarizes those studies, and draws conclusions on the potential impact on FSS systems.

A3.3. 1 Single interferer

A study considered the case of single-entry interference potential from UWB systems into FSS receivers (feeder links for the MSS).

Using the systems parameters for MSS feeder links (Section A8.7), the impact of a single UWB device into an MSS feeder link in the FSS was simulated. The propagation was modelled using a combination of generic UWB propagation model with log-normal shadow fading with mean value of 2.21 dB, smooth earth diffraction model (Rec. ITU-R P.526) and clutter model as given in Rec. ITU-R P.452). The physical arrangement simulated was as follows:

TABLE 4

UWB and MSS feeder link earth station analysis parameters

Parameter	Value
Protection criteria	*I/N* = –20 dB (average (RMS) interference power)
Antenna height	10 metres
Antenna elevation angle	10 degrees
UWB device height	2 m
Measurement bandwidth	1 MHz

A3.3.3 Conclusion for FSS Downlink

The aggregate effect of a population of UWB devices on the FSS in the downlink direction mainly depends on the type of UWB deployment, the density of devices using UWB technology and the relative proportions of indoor and outdoor use.

The studies have shown that, in most of the cases, this aggregate effect cannot adequately provide the *I/N* level of –20 dB into FSS earth station receivers without mitigating the aggregate interference from UWB devices operating at an e.i.r.p. level of –41.3 dBm/MHz. This mitigation may require a significant minimum separation distance between the population of UWB devices and FSS earth station of as much as 1

– 3 km, or a limit in the density of devices using UWB technology.
Given practical considerations, and the existing deployment of FSS earth stations, it may not be possible to achieve such exclusion zone distances of 1-3 km in many cases, and in order to achieve the *I/N* ratio of –20 dB in the band, with assumed practical exclusion zones (100 m rural/50 m semi-urban/10 m urban), it seems to be more appropriate to propose a reduction of the e.i.r.p. density levels of UWB devices in order to achieve the *I/N* ratio of –20 dB into the FSS.

The results of the studies suggest a range of possible e.i.r.p. density values for devices using UWB technology, depending upon the assumptions made for FSS deployment and for operation of UWB devices. For an FSS earth station located in an urban area, the range is –77 to –61.9 dBm/MHz; for the same deployment in a suburban area, this range is –63 to –47.3 dBm/MHz; and in a rural area, this range is –53 to –41.2 dBm/MHz. However, it would be impractical for devices using UWB technology to adjust their e.i.r.p. density depending on their location. Furthermore, the applications anticipated for UWB devices suggest a much higher likelihood of urban deployment. Therefore, a single value consistent with the urban scenario seems most appropriate in the bands 3.4-4.2 GHz and 4.5-4.8 GHz.

A3.4 Conclusions for FSS studies (uplink and downlink)

The results of aggregate studies for the Earth-to-space direction (uplink) indicate that the FSS protection criterion of no more than 1% aggregate interference into the satellite receiver will be met provided that the maximum UWB device eirp density does not exceed – 41.3 dBm/MHz.
In respect of the FSS feeder links (downlink) for MSS, the following conclusions were drawn assuming a single UWB emitter with PRF not less than 1 MHz:

- Separation distances (Single entry)
  - A minimum separation distance ranging from 39.8 m to 600 m, depending on the PRF, is required for interference from average power UWB emissions.
  - A minimum separation distance ranging from 39.8 m to 990 m, depending on the PRF, is required for interference from peak power non-dithered emissions.

– A minimum separation distance ranging from 592 m to 990 m, depending on the PRF, is required for interference from peak power dithered non-dithered emissions.

- Maximum permissible e.i.r.p. density in 1 MHz bandwidth at 10 m distance
  - The maximum permissible e.i.r.p. density is equal to –63.56 dBm/MHz for average power emissions (both non dithered and dithered).
  - The maximum permissible e.i.r.p. density is equal to –86.57 dBm/MHz for peak power emissions (both non dithered and dithered).

The results of aggregate studies for the space-to-Earth direction (downlink) are summarized in the Table below. The right-most three columns of the Table indicate the maximum UWB device emission level allowed in order that the FSS protection criterion of no more than 1% aggregate interference into the earth station receiver is maintained.

The results calculated for average emissions from a non-dithered UWB signal were as follows:

TABLE 5

Non-dithered UWB signal into an MSS feeder link earth station (UWB height 2 m)

PRF (MHz)	BWCF (dB)	Max acceptable UWB e.i.r.p. at 10 m distance (dBm/MHz)		Separation distance (m) for UWB e.i.r.p. = –41.3 dBm/MHz rms	
		System 1	System 2	System 1	System 2
0.001 to 1.0	16.02	–62.25	–63.56	501	592.5
10	6.02	–52.25	–53.56	117	146
100	0.00	–46.23	–47.54	23.8	39.8
500	0.00	–46.23	–47.54	23.8	39.8

The results therefore suggest a range of possible e.i.r.p. density values for devices using UWB technology, depending upon the assumptions made for FSS deployment and for operation of UWB devices. For an FSS earth station located in an urban area, the range is –77 to –61.9 dBm/MHz; for the same deployment in a suburban area, this range is –63 to –47.3 dBm/MHz; and in a rural area, this range is –53 to –41.2 dBm/MHz. However, it would be impractical for devices using UWB technology to adjust their e.i.r.p. density depending on their location. Furthermore, the applications anticipated for UWB devices suggest a much higher likelihood of urban deployment. Therefore, a single value consistent with the urban scenario seems most appropriate in the bands 3.4-4.2 GHz and 4.5-4.8 GHz.