



International Civil Aviation Organization

**THE THIRD WORKING GROUP MEETING OF MODE S DOWNLINKED
AIRCRAFT PARAMETERS (MODE S DAPs WG/3)**

Web-Conference, 12 -15 May 2020



中国民用航空局
空中交通管理局
Air Traffic Management Bureau .CAAC

Agenda Item 3: Sharing of State's Implementation on Mode S

**IP/06 Mode S Radar Parameter Set and DAPs Extraction Strategy
(Presented by China)**





➤ Radar Implementation in China

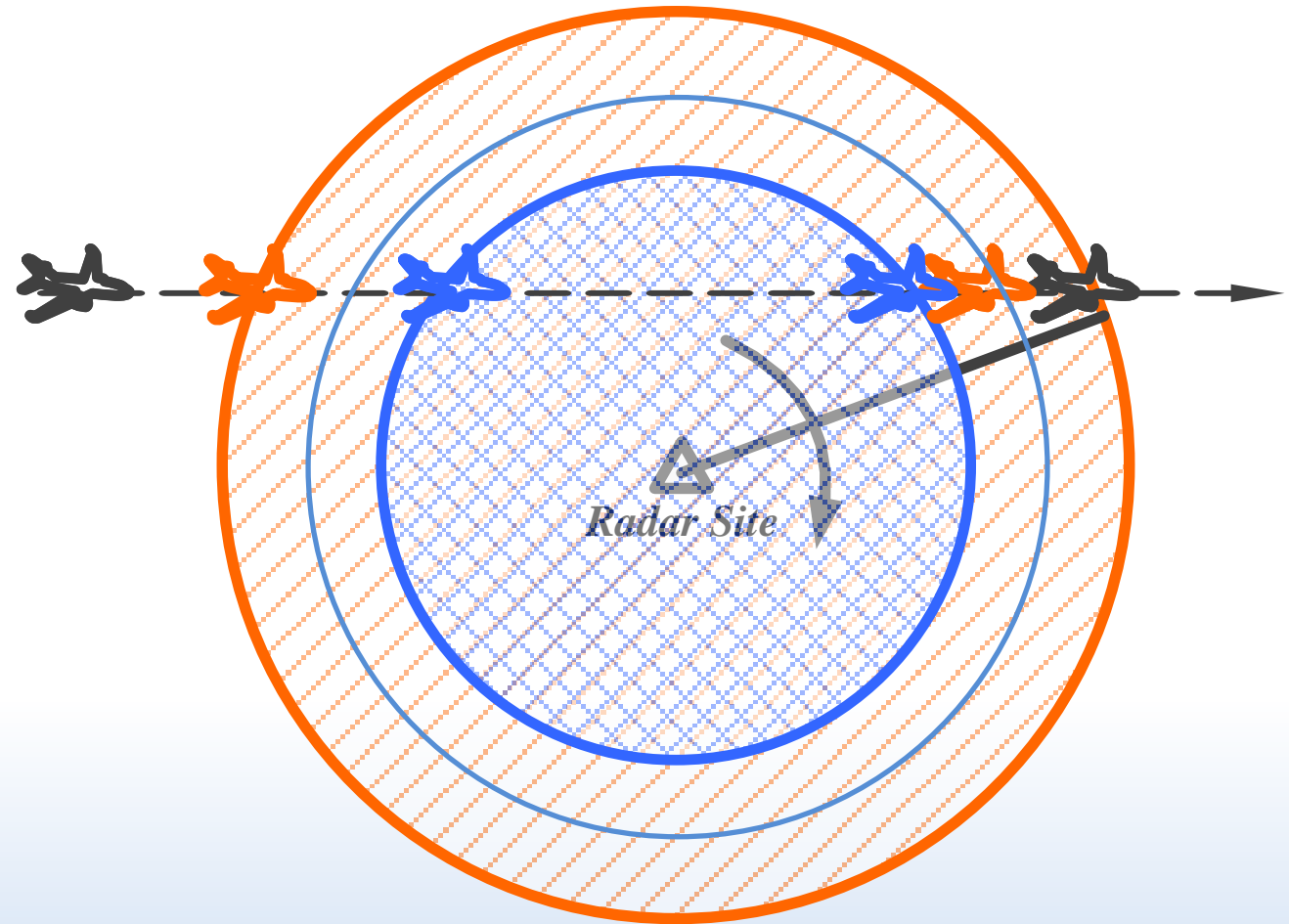
- ❑ More than 100 SSRs (74 are Mode S)
- ❑ Mode S Enhanced Surveillance, DAPs implementation
- ❑ Radar Manufactures - Thales, Leonardo, Indra, Nriet, Suncreat

➤ Radar Operation in China

- ❑ Standardize Mode S radar operation
- ❑ Optimize DAPs Extraction

➤ Radar Coverage R

- ▣ Surveillance Coverage
- ▣ Lockout Coverage



➤ Antenna Period T_a

- ❑ Low antenna period means more time resource

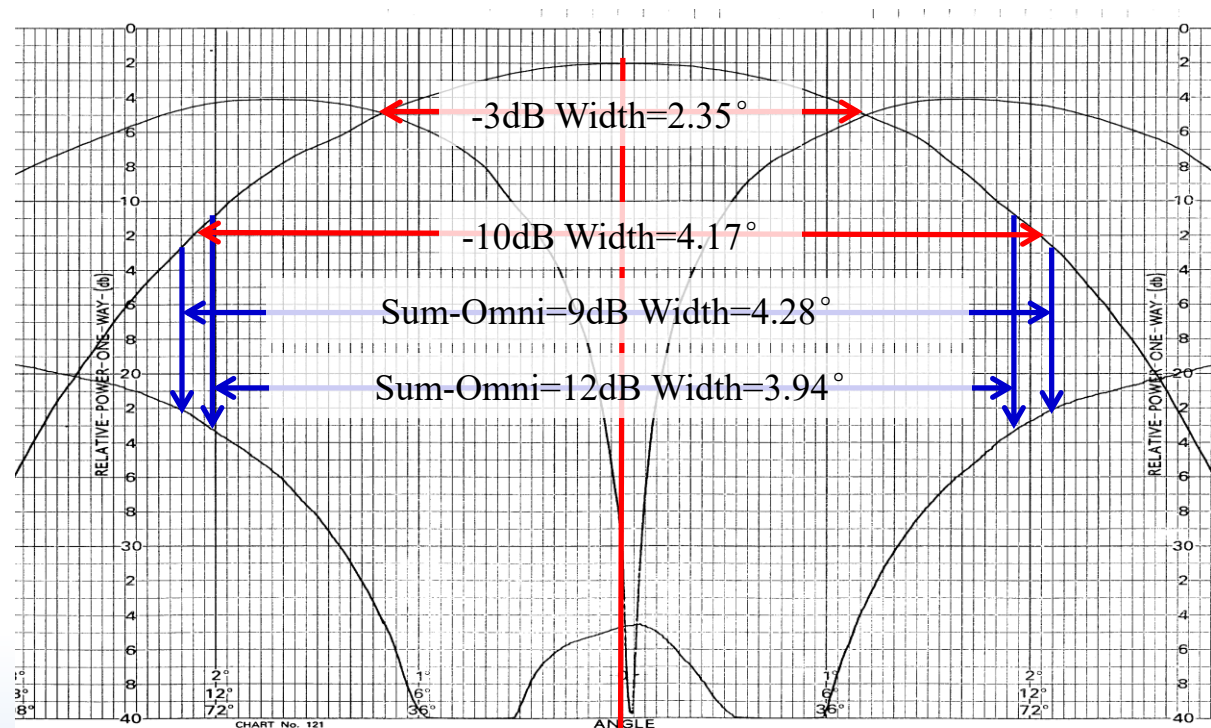
➤ Antenna Beamwidth B

- ❑ Beamwidth by -3dB = $2.45^\circ \pm 0.25^\circ$
- ❑ Beamwidth by sidelobe suppression
- ❑ Typical value is -10dB width or 3.8°

➤ Time on Target T_t

- ❑ Time resource limit in one scan

$$T_t = \frac{T_a}{360} * B$$





➤ All-Call Period *Tac* and Roll-Call Period *Trc*

- ❑ All-Call period should long enough to allow the coverage requirement;
- ❑ Time resource should allocate to Roll-Call as much as possible; and
- ❑ Algorithm should be used to optimize the scheduling in the Roll-Call period.
- ❑ During the time on target, the Necessary Transaction* should be guaranteed;

*Note: During a mixed airspace (Conventional targets and Mode S targets in the same area in the same time), there is a need for the Necessary Transaction. That means during an Time on Target, there should be at least 4 transactions between the radar and the conventional target (2 for Mode A and 2 for Mode C) in order not to miss the conventional target.



➤ Mode Interlace Pattern *MIP*

- Define the radar's operating mode

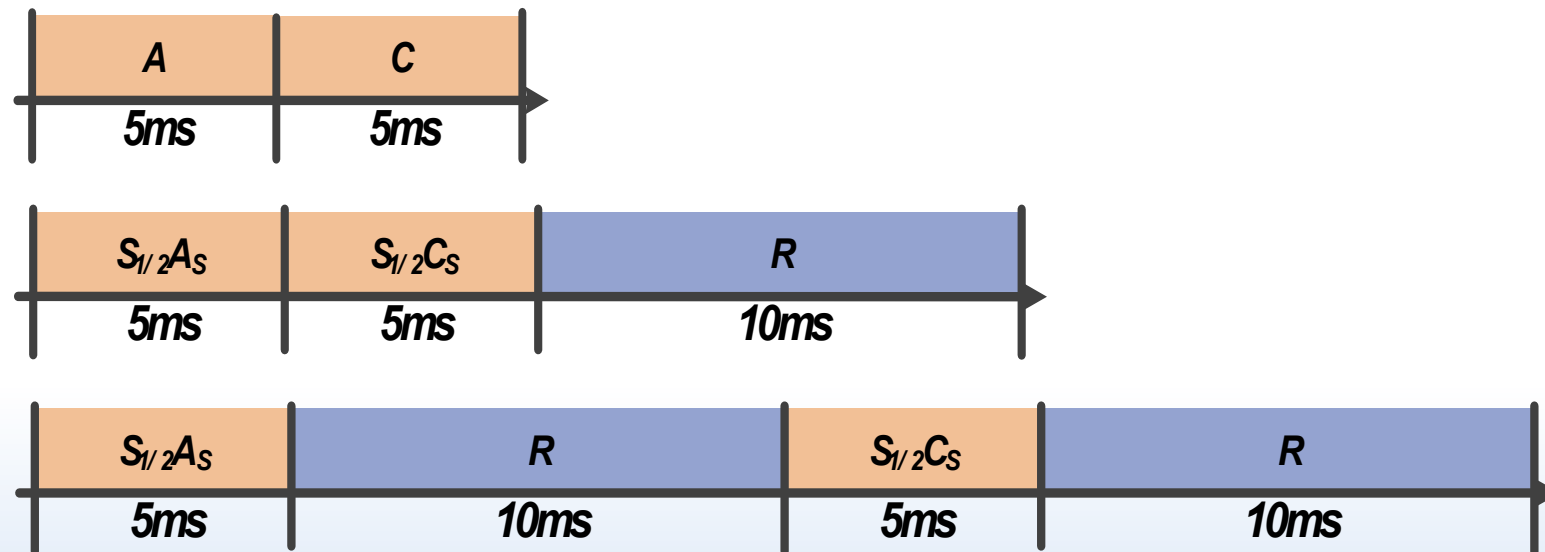
No	Mode	Description	Pulse Used
1	A	Mode A interrogation	8 μ s between P1 and P3
2	C	Mode C interrogation	21 μ s between P1 and P3
3	A _S	Mode A Only All-Call	8 μ s between P1 and P3, and short P4
4	C _S	Mode C Only All-Call	21 μ s between P1 and P3, and short P4
5	S _L	Mode ACS All-Call	8 μ s, 21 μ s between P1 and P3, and Long P4
6	S _{PO}	Mode S Only All-Call P for PR,O for LO	2 μ s between P1 and P2, and P6 UF11 inside P6
7	R	Mode S Roll-Call	2 μ s between P1 and P2, and P6 UF0/4/5/16/20/21 inside P6

➤ Mode Interlace Pattern **MIP** (continued.)

- Define the radar's MIP

Mode[Time]/ Mode[Time]/ Mode[Time]/.....

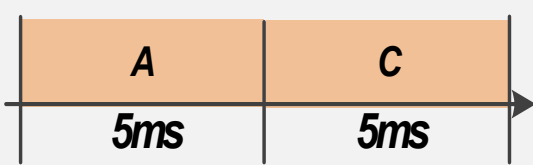
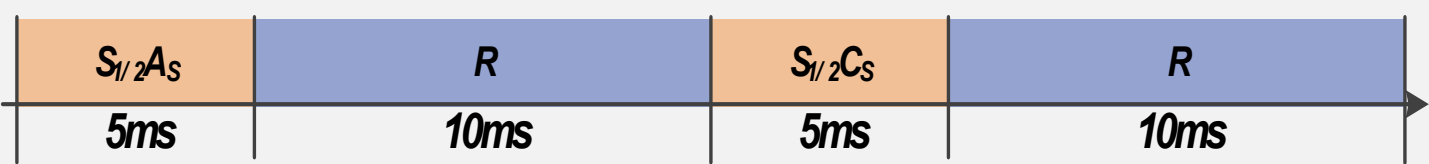
- Example



➤ Interrogation Repetition Frequency **IRF**

- ❑ PRF vs. IRF
- ❑ Define radar's IRF by Mode

IRF_{Mode}

No	MIP	IRF
1	<p>A[5.0]/C[5.0]</p> 	$IRF_A = 100\text{Hz}$ $IRF_C = 100\text{Hz}$ $IRF_{AC} = 200\text{Hz}$
2	<p>$S_{1/2}A_s[5.0]/R[10.0]/S_{1/2}C_s[5.0]/R[10.0]$</p> 	$IRF_A = 38.5\text{Hz}$ $IRF_C = 38.5\text{Hz}$ $IRF_{AC} = 76.9\text{Hz}$ $IRF_S = 76.9\text{Hz}$ $IRF_R = 76.9\text{Hz}$



➤ DAPs Extraction Strategy

- ❑ BDS number stands for the setting of the number of BDSs which radar is going to extract. It doesn't include the ELS registers, these registers should not be extract periodically;
- ❑ Extraction priority stands for the priority of each BDS when the radar is performing extraction, the priority should be in accordance to the user's needs;
- ❑ Extraction period stands for the period of the dedicated BDS extraction, normally described by the antenna scan number;
- ❑ Re-extraction stands for the function of re-extraction of the dedicated BDS in the same beam dwell when the extraction is failed, but it's not recommend to re-extraction of more than 2 times.

Mode S Radar Parameter Set and DAPs Extraction Strategy



➤ Example

No	Parameter	Unit	Value	Note
1	R/Coverage Range	NM	200	Equivalent All-Call Time $\frac{200*2*1852}{3*10^8} * 10^3 \approx 2.47ms$
2	Ta/Antenna Period	ms	3800	Antenna Rotation Period
3	B/Work Beamwidth	°	3.8	Greater Than -3dB width of 2.45°
4	Tt/Time on Target	ms	40.1	The Time on Target In One Scan $\frac{3.8}{360} * 3800 \approx 40.1ms$
5	Tac/All-Call Period	ms	3.0	Equivalent Coverage Range $\frac{3*10^8*3.0*10^{-3}}{1852*2} \approx 243NM$
6	Trc/Roll-Call Period	ms	7.0	This Period Related To The Extraction Efficiency
7	MIP	—	—	$S_{1/2}A_s[3.0]/R[7.0]/S_{1/2}C_s[3.0]/R[7.0]$
8	IRF _{AC}	Hz	100	Interrogation Repetition Frequency of Mode S All-Call
9	DAPs Extraction	—	—	No. of BDS: 3 (BDS 4,0 5,0 6,0) Extra. Priority: BDS 4,0 6,0 5,0 Extra. Period: 1 Scan Re-Extraction: Yes



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Thank You

