

S-400 Triumpf System	Possible Early Warning [6]			Missile Battery Tracking and Launch Decision					Missile Launch and Flyout				
Equipment Type	91N6 Big Bird (similar for 59N6 Protivnik)			96L6 BAR	92N6E Tombstone		55K6E		48N6E3 / SA-21				
Nominal Detection/Flight Range/Freq.	S-400 Early Detection / Battle Management 100km / 2.5GHz			S-400 Battery Acquisition 100km / 3.5GHz	S-400 Battery Engagemen 100km / 1.5GHz		S-400 Command Post N/A		S-400 Surface to Air Missile 250km N/A 2,100m/sec				
Circular Sweep Rate (Seconds) [1]	6 or 12			5.5 or 6	N/A		N/A						
Flight Speed	N/A			N/A	N/A		N/A						
Engagement Sequence Entry Points:	1			2									
Sequence Status:	UNDETECTED	ACQUISITION	HANDOVER [9]	ACQUISITION	TRACKING	SLEW / CUE	TRACKING	LAUNCH DECISION [17]	LAUNCH	ORIENT	FLYOUT [20]	ENDGAME	IMPACT
Sequence Status ID:	00	01	02	03	04	05	06	07	08	09	10	11	12
Target Detectable + Maintained LOS [2]:													
91N6 Big Bird >>	[7]			[10]									
96L6 BAR >>				[11]		[15]							
92N6 Tombstone >>											[21]		
48N6E3 / SA-21 >>												[23]	[25]
Engagement Required Times (Seconds):													
Radar Acquisition and Tracking													
Min...Max [3]		4.5 + 12...24	3...9	3 + 11...12	1...5	3 + 1...10 [16]	1...5						
Average		22.5	4.5	14.5 [12]	2.5	6.5	2.5						
Staff Evaluation and Decisions													
Min...Max			2...5					1...30 or 10...30 [18]					
Average			2.5					5					
SAM Missile Gyro Spinup								10 [19]					
Launch / Flight Time									3...10	0.5	km*0.5-(5...10)[22]	5...10	-
Average									6.5	0.5	km*0.5-7.5	7.5	-
Cumulative Times (Seconds):				[13]							(at nominal 20km)		
Min...Max	-	16.5...28.5	21.5...42.5	35.5...57.5	36.5...62.5	40.5...75.5	41.5...80.5	42.5...110.5	45.5...120.5	46...121	51...141	54...151	54...151
Max-minus-Min Mean	-	22.5	32	46.5	49.5	58	61	76.5	83	83.5	96	102.5	102.5
Simulated Cumulative Seconds	0	22.5	29.5	44	46.5	53	55.5	60.5	67	67.5	70	77.5	77.5
Seconds for Loss of Target [4]:	-	9	4.5	6	5	5	5	5	6	2	2	1 [24]	-
Integrated Events:	-	[8]	-	[14]	-	-	-	-	-	-	-	-	[26]
Algorithm Movement Cost Multiplier [5]:	x 1	x 5	x 10	x 15	x 20	x 25	x 30	x 35	x 40	x 45	x 50	x 1,000	x 10,000

- NOTES IN BRACKETS [ ]:
- 1 A minimum of two radar sweeps is required to detect and acquire a target
  - 2 "Detectable" is defined as the radar cross section aspect shown of the target having a probability of detection greater than 90% for given radar equipment performance specification:  
"LOS" is defined as a clear straight-line path ("line-of-sight") existing between the radar and the target containing no terrain or other obstructions
  - 3 For radar sweeps, preliminary value is 180 degree average sweep/slew distance to be covered before first target return (90 degree in case of 91N6 as it is dual-faced)
  - 4 This is the loss of consecutive target track time that makes it necessary for the sequence be started from scratch at Entry Point 1 or 2 in order to reacquire a target
  - 5 A danger-escalation cell movement cost "penalty" multiplier for the A\* Algorithm. Used for potential movement evaluation during each status indicated
  - 6 Early detection may take place if the TLAM is observable within range and LOS of any system early detection radar
  - 7 TLAM will remain undetected by flying behind terrain masking and/or remaining out of detectable radar range
  - 8 A. Brigade command post notified. + B. All IADS assets put on sector alert. + C. All system missile gyros are spun up
  - 9 Involves delay for human interpretation and decision
  - 10 91N6 Big Bird and 96L6 BAR detection should be concurrent at this point for most efficient handover
  - 11 96L6 BAR can autonomously acquire targets with 2 radar sweeps of a detectable object
  - 12 Half this value (7.25 seconds) is used if Early Warning exists.
  - 13 With Sequence Entry Point 2, cumulative time value at Handover (29.5 Seconds) can be subtracted
  - 14 For autonomous battery acquisition, missile gyro spinup will occur at this time
  - 15 96L6 BAR and 92N6E Tombstone detection should be concurrent until launch decision is complete
  - 16 3 second average initial slew is removed if Early Warning exists.
  - 17 Possible existence of an S-400 "full automatic" mode may preclude any battery decision delays if it is activated
  - 18 10...30 if no Early Warning and/or missile gyro spinup is necessary
  - 19 Necessary if no Early Warning--may or may not be on critical time path for missile launch
  - 20 The 48N6E3 missile guidance control algorithm uses a modified p-Nav approach where missile aims for projected target location at time of impact
  - 21 Only 92N6E Tombstone tracking is necessary during missile flyout, however a 2 second detection loss will result in errant missiles that do not impact the target
  - 22 Includes 5% time penalty for missile control maneuvering delays and non-direct flight. 7.5 seconds is subtracted for average Endgame phase length
  - 23 No radar tracking is necessary during final 7.5 seconds of missile endgame for selectable missile types
  - 24 Loss of target to radar track during missile endgame is not relevant--missile relies here on internal TVM/SAGG guidance. LOS to missile location is evaluated instead in Endgame
  - 25 Salvos of 2 missiles are normally fired, making the probability of missile misses insignificant for a slow-moving TLAM type target
  - 26 TLAM destruction -- probability 100%.