Operationally Responsive Mission Engineering (ORME)

NDIA

25th Annual Systems and Mission Engineering Conference

November 3, 2022

Operationally Responsive Mission Engineering

The application of

Digital Mission Engineering methods

to current and emerging

US, Allied, threat and commercial systems

operating in designated

areas of interest.

System Digital Twin Ancestry

No Digital Twin

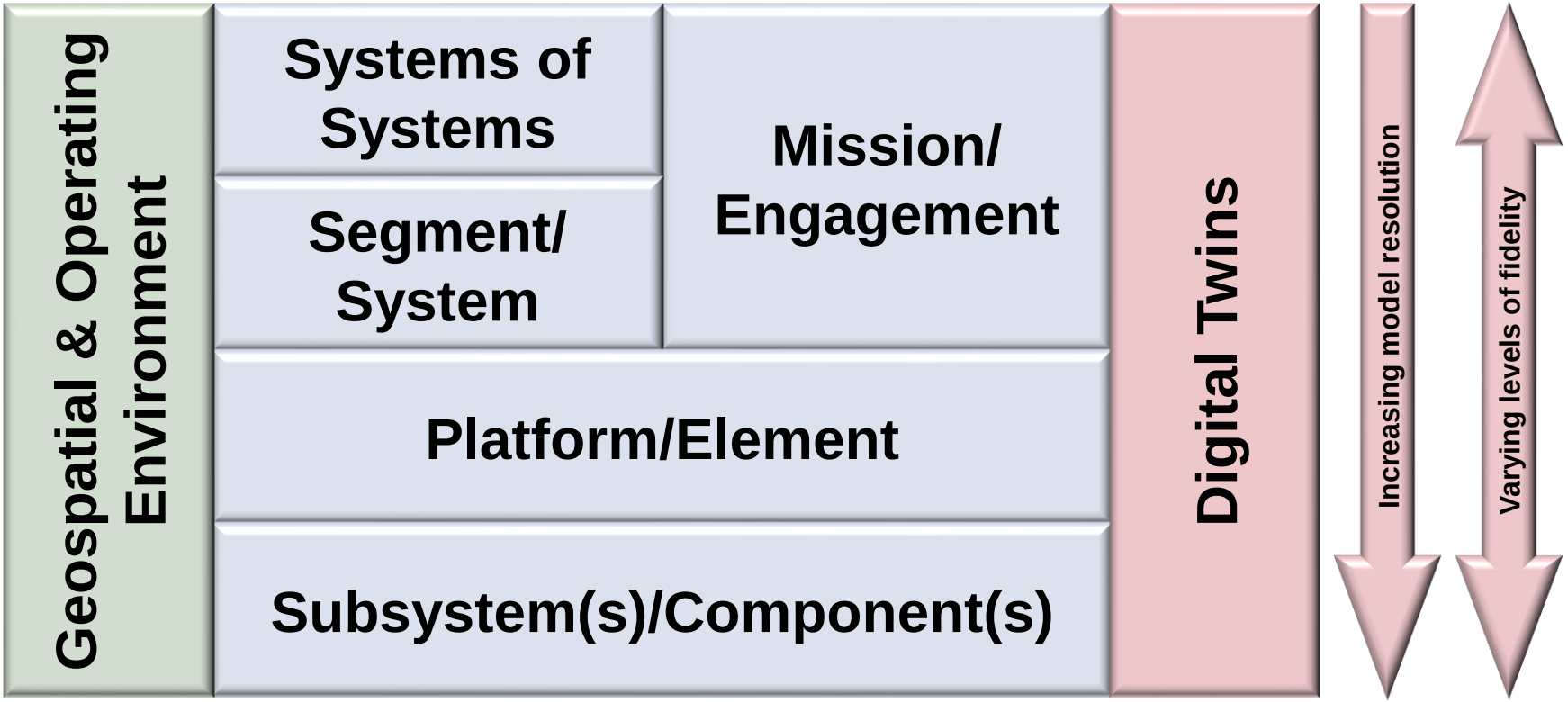
Fleet Enterprise Twin

Classified

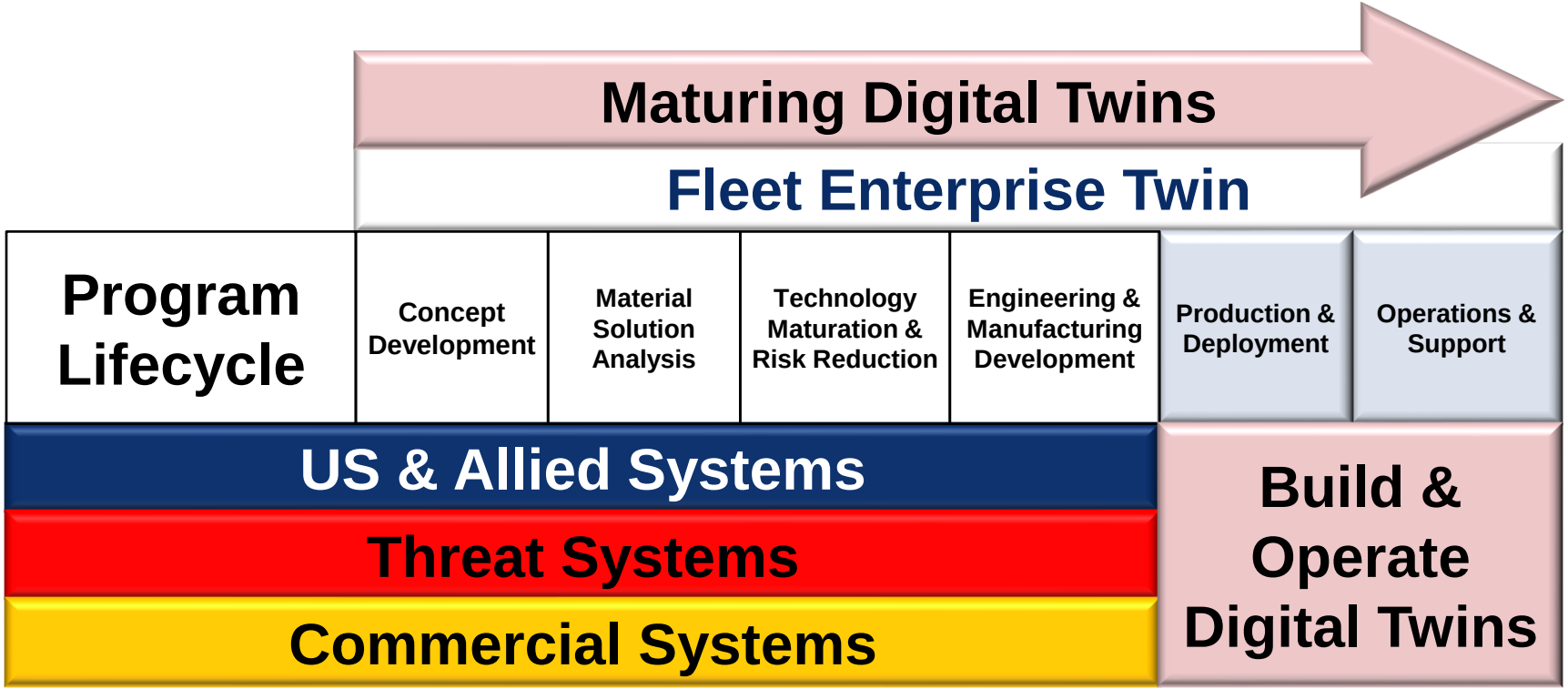
Open Source

Proprietary

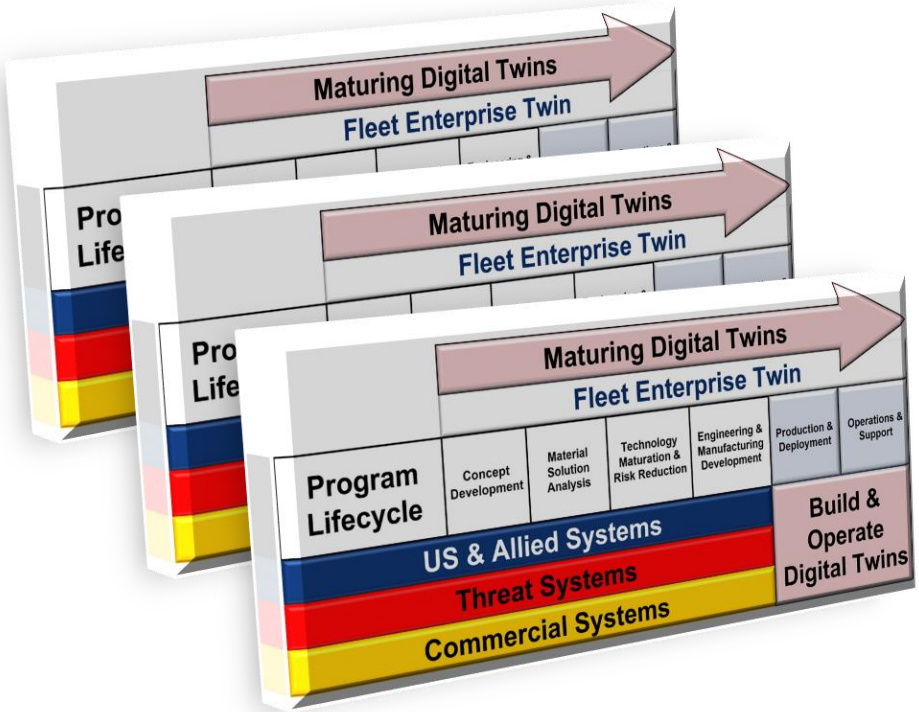
Mission Model Hierarchy (MMH)



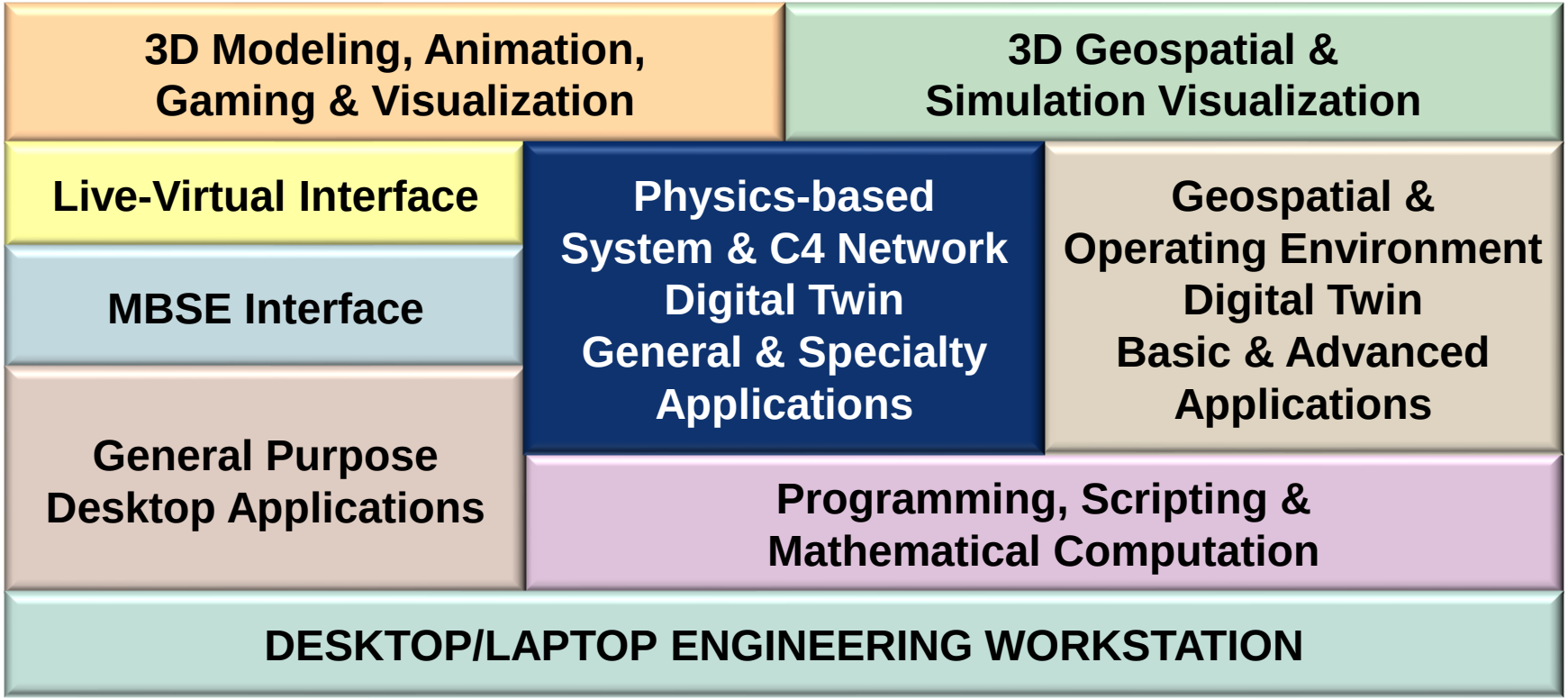
Cradle-to-Grave Digital Mission Engineering



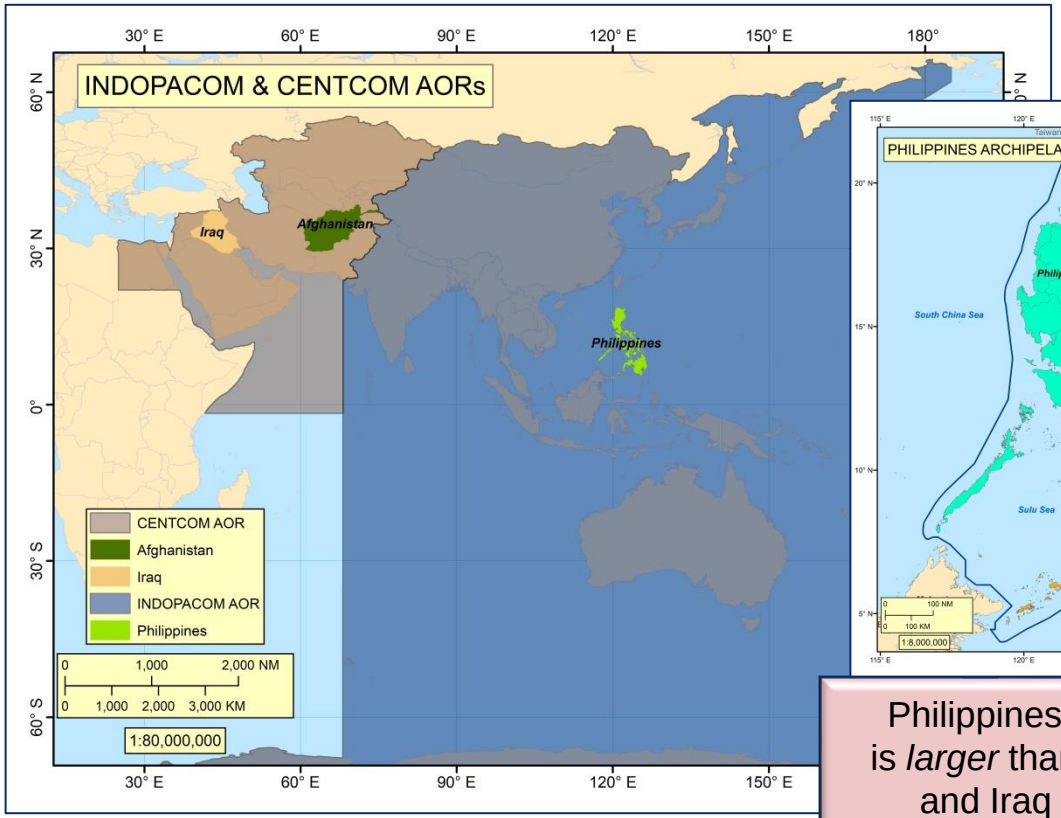
Operationally Responsive Mission Engineering

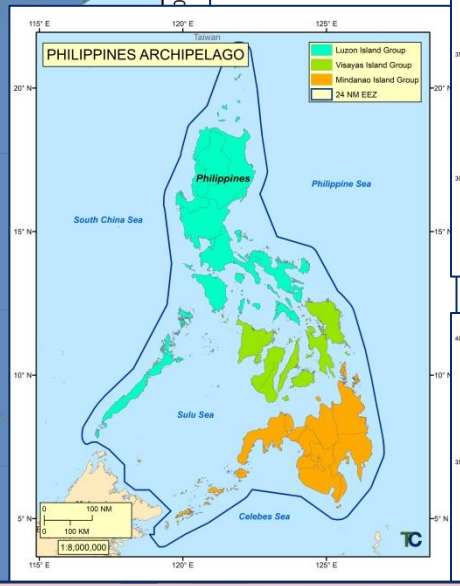


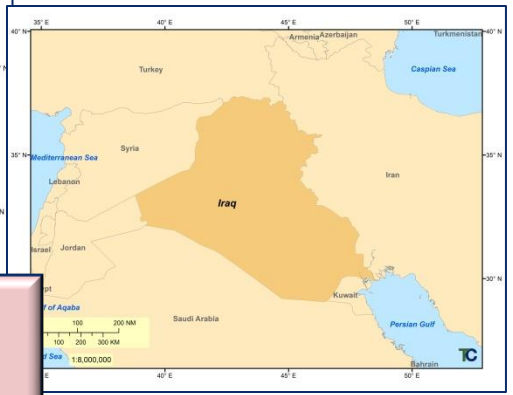
Digital Mission Engineering Environment (DMEE™)



Geospatial Digital Twins: Custom Maps

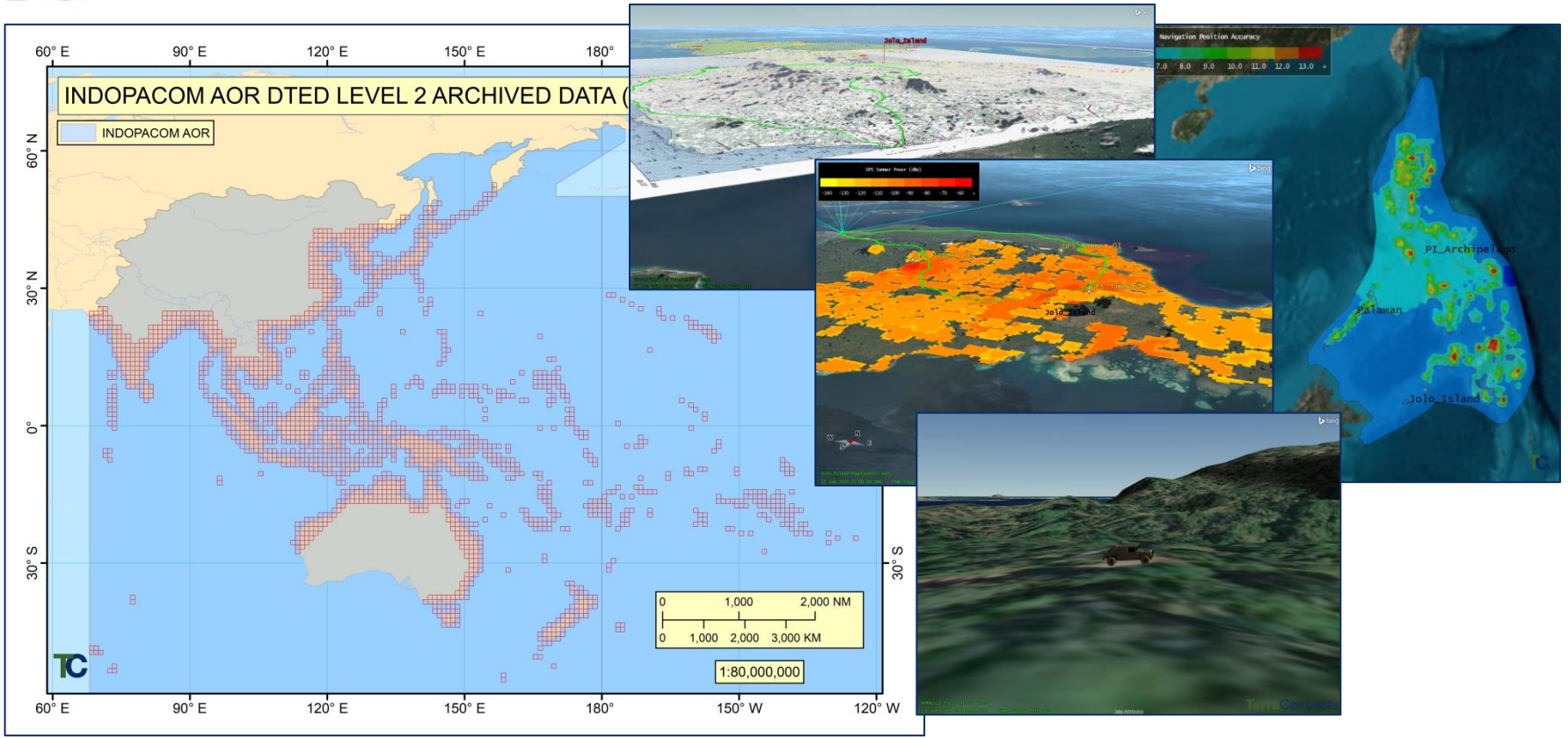




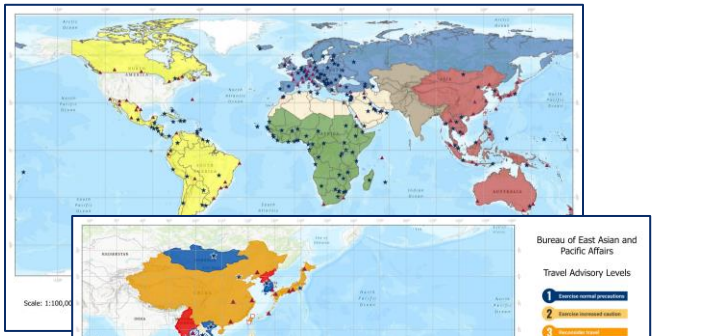


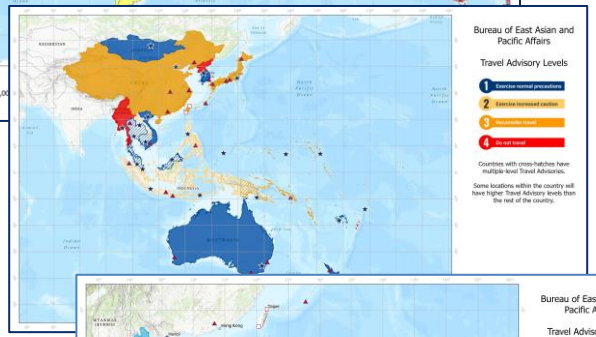
Philippines Archipelago is *larger* than Afghanistan and Iraq *combined*.

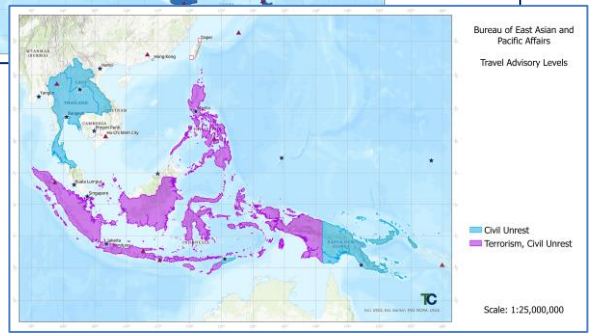
Geospatial Digital Twins: Digital Terrain Data



Geospatial Digital Twins: Geospatial Databases





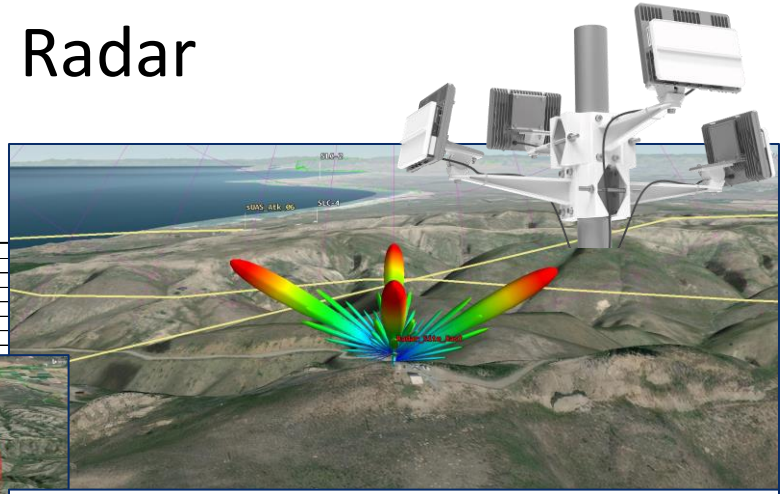


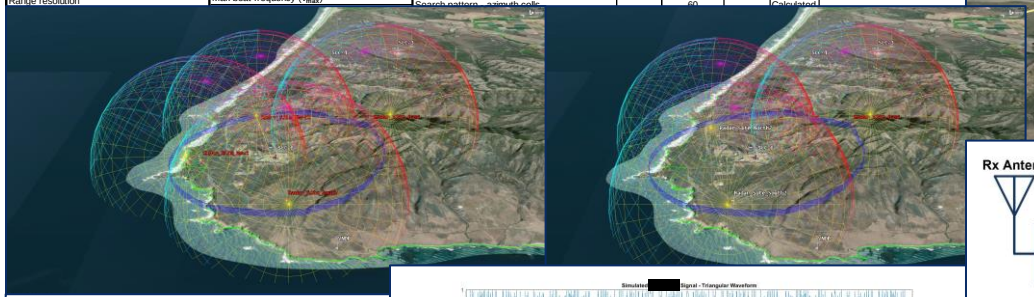
System Digital Twins: FMCW Radar

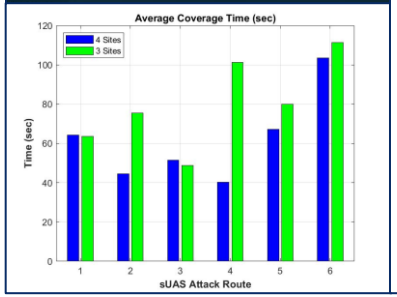
RADAR PARAMETER	SYMBOL	VALUE	UNITS	SOURCE/COMMENTS	
RF band		K		Given	Spec sheet
RF lower end frequency	f_1	24.05	GHz	Given	Spec sheet
RF upper end frequency	$f_$	24.25	GHz	Given	Spec sheet
RF center frequency					
RF Bandwidth					
RF wavelength at center frequency					
FMCW waveform					
Max (Instrumented) range					
Pulse round trip time					
FM bandwidth sweep					
Range resolution					

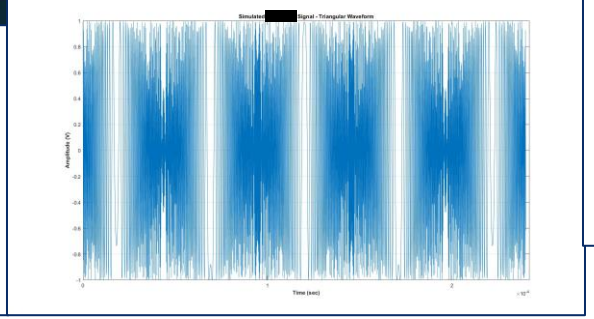
RADAR PARAMETER	SYMBOL	VALUE	UNITS	SOURCE/COMMENTS
Beat frequency max (instrumented) range	$f_{bmax\,rng}$	7.850	MHz	Calculated
Beat frequency/range ratio		1.31	kHz/m	Calculated
Range/beat frequency ratio		0.76	m/kHz	Calculated
Min beat frequency interval				
Target spectral width				
Range resolution limit				
Maximum target speed				
Doppler shift (v_{max})				
Max beat frequency (v_{max})				

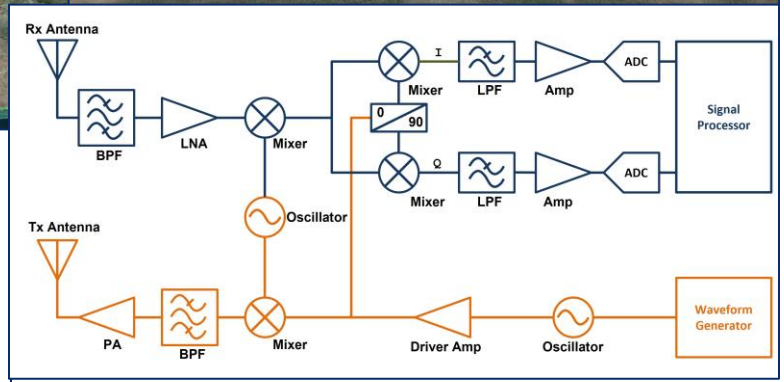
RADAR PARAMETER	SYMBOL	VALUE	UNITS	SOURCE	
Window range resolution (6 dB)		5.76	m	Calculated	
Search update (scan) rate		1	Hz	Given	Spec sheet
Search volume - azimuth		120	deg	Given	Spec sheet
Search volume - elevation		60	deg	Given	Spec sheet
Angular resolution - azimuth		2	deg	Given	Spec sheet
Angular resolution - elevation		6	deg	Given	Spec sheet
Search pattern - azimuth cells		60		Calculated	



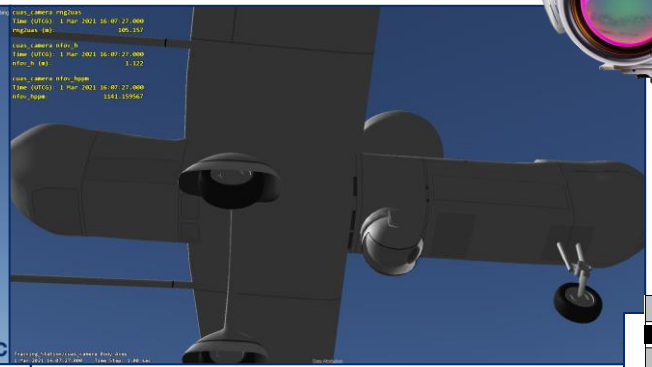


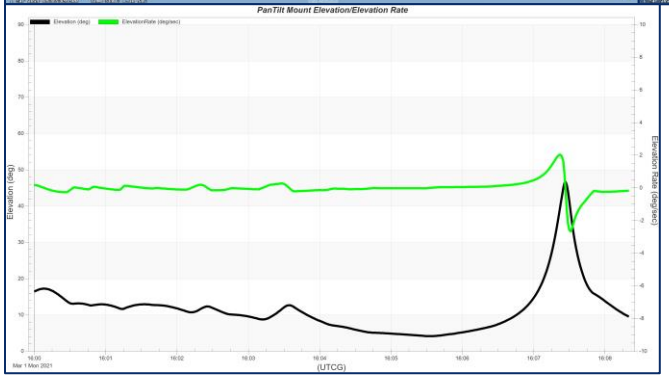






System Digital Twins: EOIR Cameras

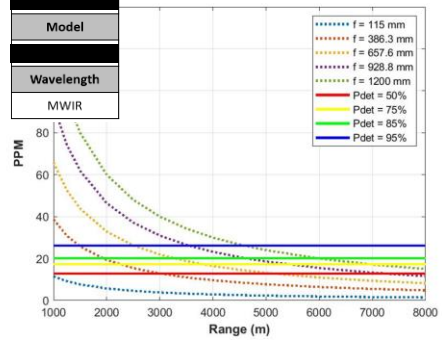




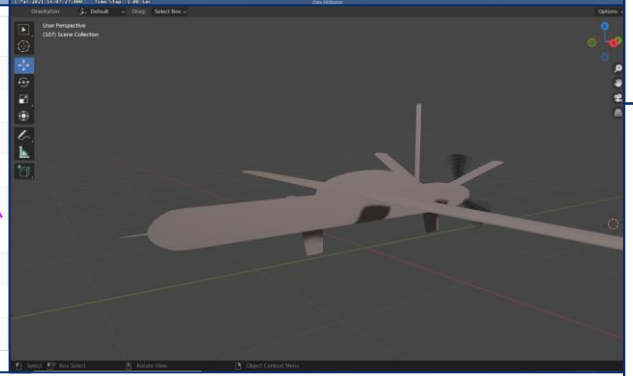
Vendor	[redacted]	Wavelength	Visible/NIR
Model	[redacted]	Sensor	1/2.8" CMOS
Resolution	1920 x 1080	Pixel Pitch	2.9 µm

		FOCAL LENGTH (mm)																								
	PPM_rms	15.4	50.0	137.0	239.0	341.0	443.0	545.0	647.0	749.0	851.0	953.0	1055.0	1157.0	1259.0	1361.0	1463.0	1565.0	1667.0	1769.0	1871.0	1973.0	2075.0	2177.0	2279.0	2381.0	2483.0
RANGE (m)	50	107	346	948	1653	2359	3064	3770	4476	5181	5887	6592	7298	8003	8709	9414	10120	10825	11531	12236	12942	13647	14353	15058	15764	16469
	100	54	173	474	827	1179	1532	1885	2238	2591	2943	3296	3649	4002	4354	4707	5060	5412	5765	6118	6470	6823	7176	7528	7881	8234
	200	27	87	237	413	590	766	942	1119	1295	1472	1648	1824	2001	2177	2353	2530	2706	2883	3059	3236	3412	3589	3765	3941	4118
	300	18	58	158	276	393	511	628	746	864	981	1099	1216	1334	1451	1569	1686	1804	1922	2039	2157	2274	2392	2510	2627	2745
	400	13	43	118	207	295	383	471	559	648	736	824	912	1000	1089	1177	1265	1353	1441	1530	1618	1706	1794	1882	1971	2059
	500	11	35	95	165	236	306	377	448	518	589	659	730	800	871	941	1012	1083	1153	1224	1294	1365	1435	1506	1577	1647
	1000	5	17	47	83	118	153	188	224	259	294	330	365	400	435	471	506	541	577	612	647	682	718	753	788	824
	1250	4	14	38	66	94	123	151	179	207	235	264	292	320	348	377	405	433	461	489	518	546	574	602	630	659
	1500	4	12	32	55	79	102	126	149	173	196	220	243	267	290	314	337	361	384	408	431	455	478	502	525	549
	2000	3	9	24	41	59	77	94	112	130	147	165	182	200	218	235	253	271	288	306	324	341	359	377	394	412
	2500	2	7	19	33	47	61	75	90	104	118	132	146	160	174	188	202	217	231	245	259	273	287	301	315	329
	3000	2	6	16	28	39	51	63	75	86	98	110	122	133	145	157	169	180	192	204	216	227	239	251	263	274
	3500	2	5	14	24	34	44	54	64	74	84	94	104	114	124	134	145	155	165	175	185	195	205	215	225	235
	4000	1	4	12	21	29	38	47	56	65	74	82	91	100	109	118	127	135	144	153	162	171	179	188	197	206

Vendor	[redacted]
Model	[redacted]
Wavelength	MWIR



System Digital Twins: Threat Systems



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https://doi.org/10.1080/08929882.2020.1846279

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Flight Performance Analysis of the Samad Attack Drones Operated by Houthi Armed Forces

Mark Voskuijl, Thomas Dekkers, and Ralph Savelsberg

Faculty of Military Sciences, Netherlands Defence Academy, Den Helder, The Netherlands

ABSTRACT

In recent years, there has been a large increase in the use of

Figure 1. Reconstruction of Samad-2, length of 2.80 m (left); Samad-1 including details of the airfoil shape at the wing root (right).[15]

Figure 2. Motor and propeller (left); Samad-3 (front) and Samad-1 (back) on a display in Sana'a Yemen (right).[16]

170 engine. The Samad-3, with an external fuel tank mounted on top of fuselage, can be seen in Figure 2

Figure 3. Close-up of Samad-1 (in Figure 1) showing the wing root airfoil (left); NACA 23018 airfoil and NACA 23009 (right).

Figure 4. Schematic representation of the Samad-2 and Samad-3. The external fuel tank on the Samad-3 is indicated with a dashed line. The dash-dotted line in the front view on the top left

Takeaways

- ORME
  - Multi-domain, multi-functional
  - US, Allied, threat & commercial systems
  - Deployment, Operations & Support
- ORME Team
  - Task organized around core team of engineers, analysts, modelers, and operators
- Analysis & visualization work products driven by requirements
  - CONOPS
  - Trade Studies
  - Test & Evaluation
  - Site Surveys
  - Wargaming & Exercises
- Geospatial digital twins essential to ORME

Questions?

Definitions

- Mission Engineering: the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to achieve desired warfighting mission effects (Defense Acquisition Guidebook)
- Digital Mission Engineering (DME): a Digital Engineering approach using digital modeling, simulation, analysis and visualization (MSAV) to create physics-based system, geospatial and operating environment digital twins
- System Digital Twin: a virtual representation of a [connected] physical asset (AIAA/AIA White Paper)
- Geospatial Digital Twin: a virtual representation of the natural and built environments (ESRI)
- Operationally Responsive Mission Engineering (ORME): the application of DME methods to current and emerging US, Allied, threat and commercial systems operating in designated areas of interest (AOI)