



Finnish Defence Research Agency

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Towards a Military Cognitive Radio System

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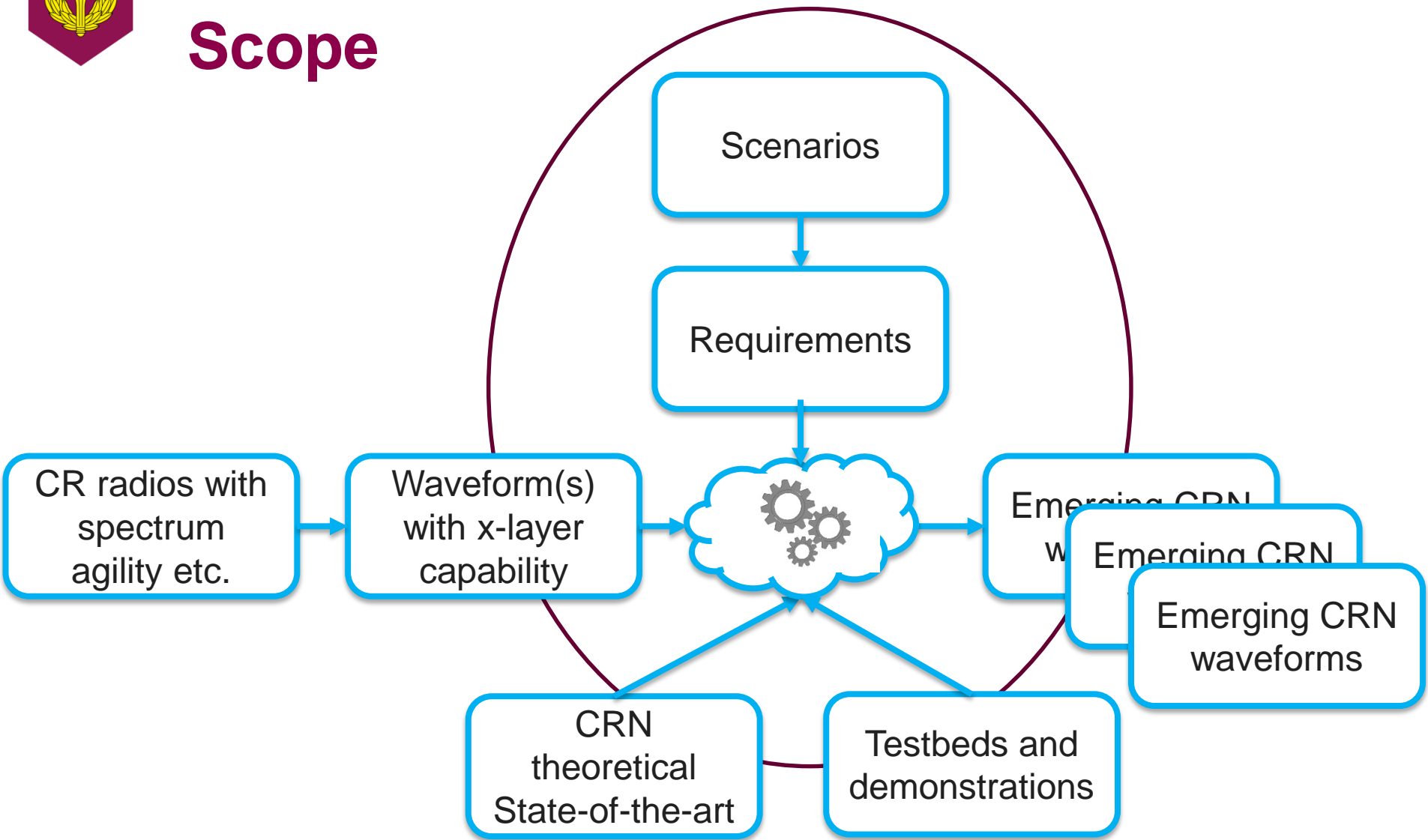


Puolustusvoimat

Försvarsmakten • The Finnish Defence Forces



Scope





Cognitive Radio System is

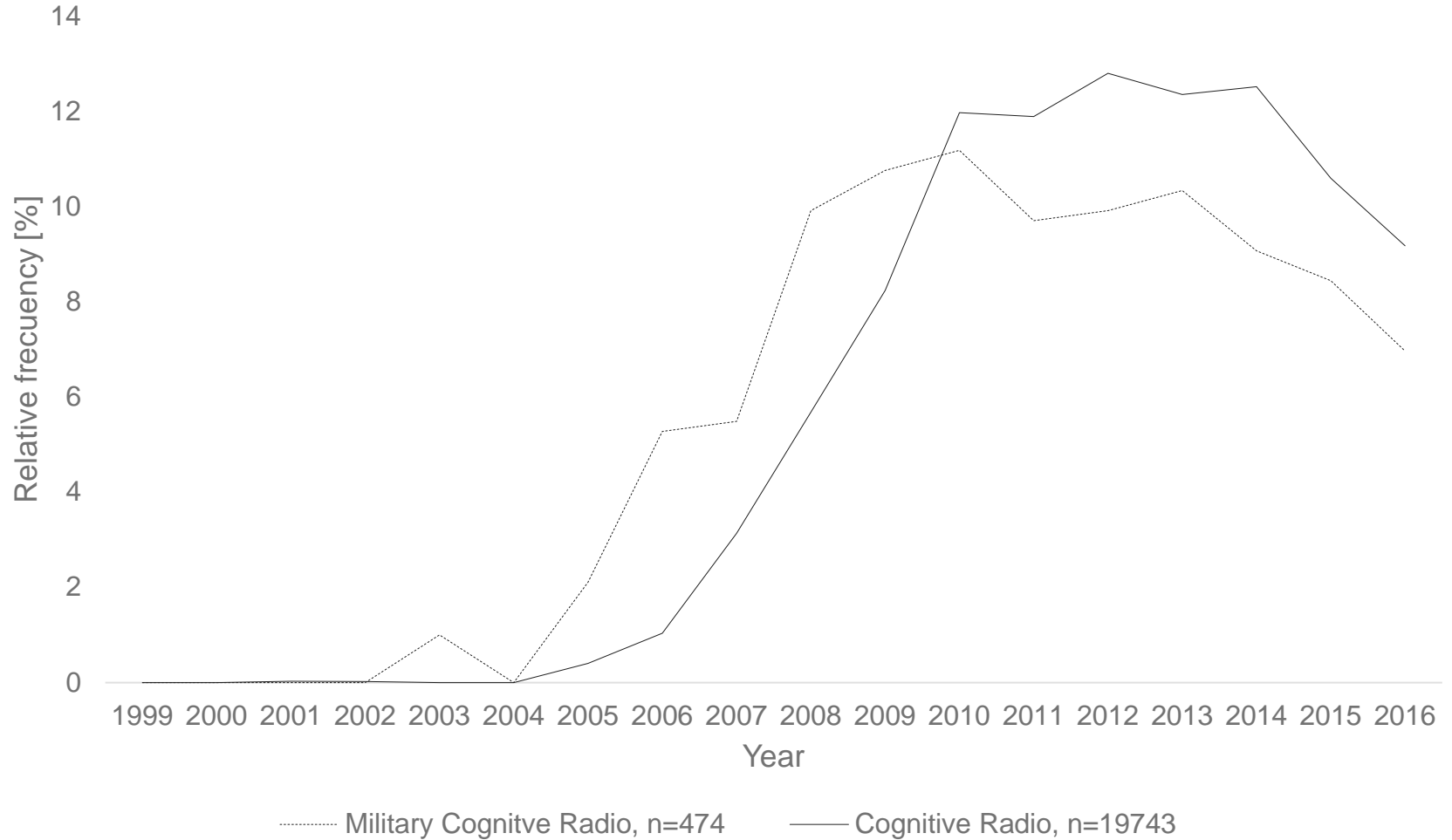
"A radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained."

Source: Definitions of Software Defined Radio (SDR) and Cognitive Radio System (CRS) ITU-R SM.2152. ITU, 2009.





Relative numbers of articles on Cognitive Radio and Military Cognitive Radio in IEEE Xplore database by year





Cognitive Radio - expected added value

WINNF-09-P-0012-V1.0.0 Quantifying the Benefits of Cognitive Radio, 2010

- Dynamic Spectrum Access
- Multiple Antenna Systems
- Radio Resource Management
- Spectrum Markets
- Single Link Adaptation
- Commercial Market Characteristics
- Public Safety Characteristics
- Military Applications





CATWOE

- a soft systems engineering approach proposed by P. Checkland: *Soft-systems Methodology*, John Wiley 1999
- Client
- Actor
- Transformation
- Worldview
- Owner
- Environment





Dynamic Spectrum Access through DOTMLPFI

- Doctrine: operational and functional benefits of improved reliability, increased availability, ease of use plus supports notions of mission command, self-synchronization, situational awareness
- Organization: improved reliability and availability of communications may offer some freedom of organizational adjustment e.g. flattening hierarchy, increasing nr of subordinates etc. Potentially more important than formal organizational structures is the implied operational flexibility the DSA would allow.
- Training: CR generally expected to reduce training burden on end user
- Materiel: first generation military CRSs expensive, deployed to the first grade operational units at first, consume more power than state-of-the-art SDR devices of that time, first expected at brigade/battalion trunk or core network, thus pushing SDR-technology towards the last mile.
- Leadership: no imminent changes in military leadership functions or practices
- Personnel: Ease of use, admin/maintenance/planning functions can be moved higher in the military organizational hierarchy
- Facilities: CRS will in the long run lead to reduction of installed radio devices on-board mobile and semi-mobile/transferrable platforms, reducing space, weight, heat dissipation, power, and ventilation requirements
- Interoperability: Interoperability may be supported





Cognitive Radio Networking through DOTMLPFI

- Doctrine: improved reliability and availability can lead to modifications in regular reporting mechanisms across military hierarchy layers.
- Organization : less burden on individual end users. Functions of Signals Corps members shift higher.
- Training: training requirements of end users should decrease
- Materiel: currently the notion of cognition challenges military acquisition/procurement offices, note: a CRN may include non-cognitive SDR devices !
- Leadership: reliable and available communications facilitates improved timely information sharing, improved situation awareness and may facilitate self-synchronization among military units.
- Personnel: changes in the roles of the members of Signals Corps in direction of network operations foreseen.
- Interoperability: interoperability itself would not necessarily be a main driver for the adoption of CRS





Use cases

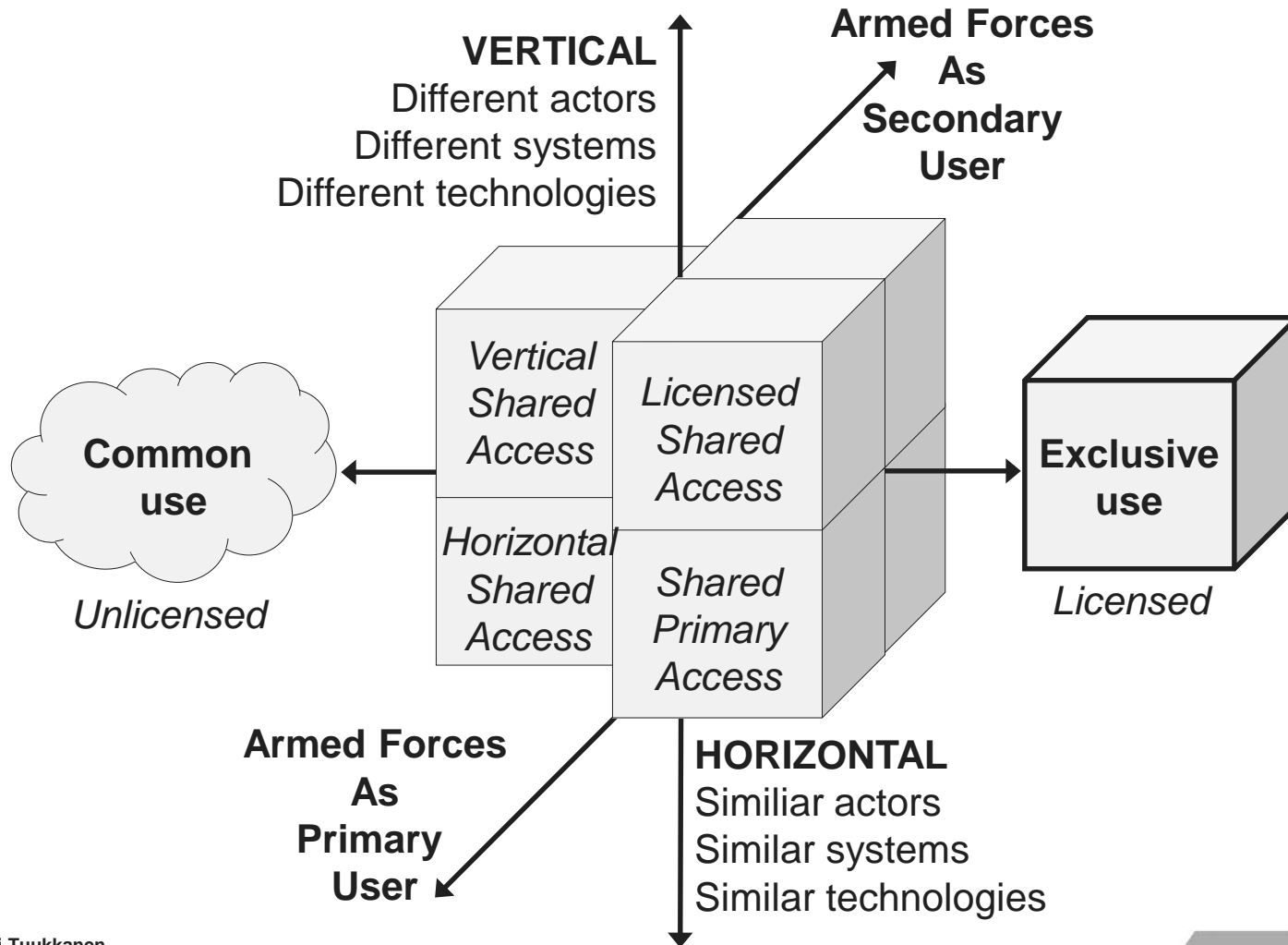
**TABLE 1. POTENTIAL SPECTRUM SHARING USE CASES
(PRIMARY USER - SECONDARY USER)**

| | | |
|----------------|-----------------|------------------|
| MIL-MIL | PS-MIL | CIV-MIL |
| MIL-PS | (PS-PS) | (CIV-PS) |
| MIL-CIV | (PS-CIV) | (CIV-CIV) |



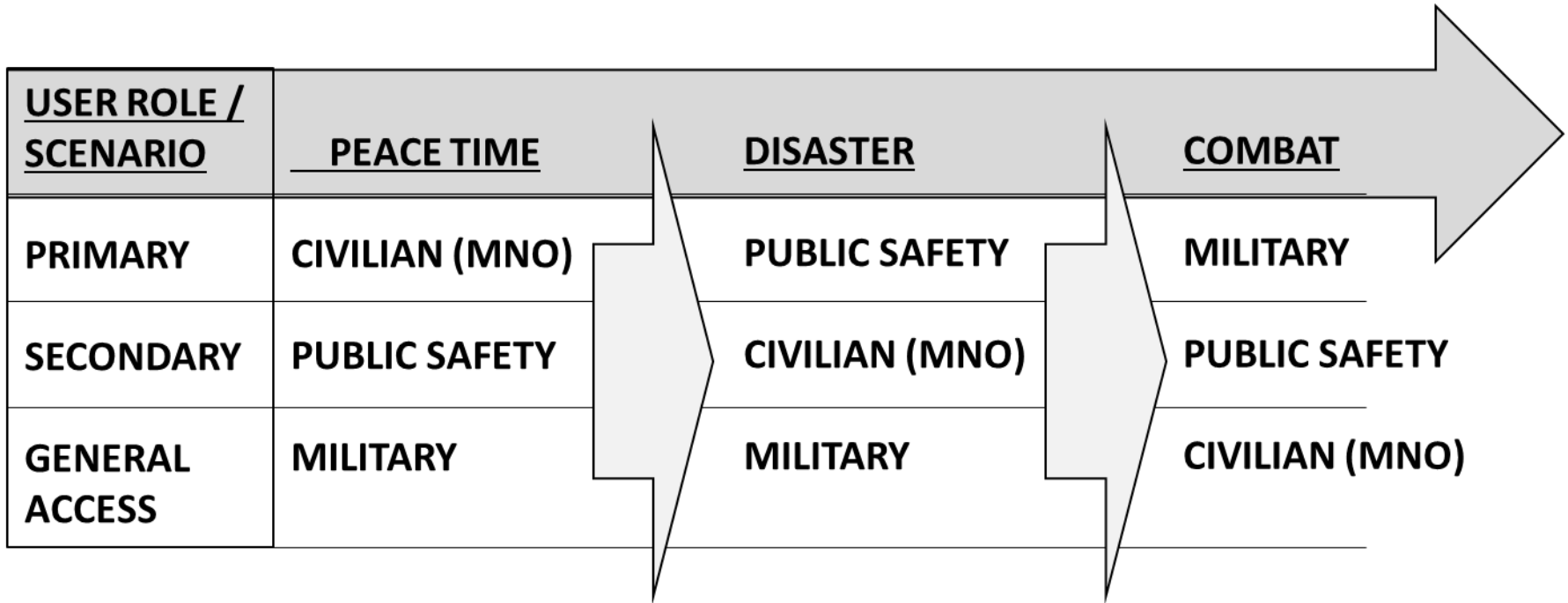


Shared Spectrum Access Option Space for the Armed Forces





Main result: spectrum sharing concept should be capable of temporal changes in user roles





Comprehensive Capability Meta Model

| aspect perspective | A. DATA What | B. FUNCTION How | C. NETWORK Where | D. PEOPLE Who | E. TIME When | F. MOTIVATION Why |
|---|--|-------------------------------|-----------------------------|-----------------------------|----------------------------|--|
| 1. SCOPE (Context) | Military power | Strategy | International relations | Political decision makers | Situational | Instrument of foreign and security policy |
| 2. BUSINESS MODEL (Concept) | Capability areas (functional) | Concepts | Military operations | Capability planners | Not applicable | Effects to accomplish the tasks |
| 3. SYSTEM MODEL (Logical model) | Defence lines of development (e.g. DOTMLPFI) | Acquisition Process | Military industrial complex | Acquisition community | Through life management | Design and acquisition of the functional capabilities as systems |
| 4. TECHNOLOGY MODEL (Physics) | Weapon system (platform-centric) | Operating Manual | Physical environment | System user | Availability (time up) | Physical embodiment of capability systems' components |
| 5. DETAILED REPRESENTATIONS (Out of context) | Sub-systems | Technical specification | System Interface | System builder | Mean time between failures | Components of platforms / systems |
| 6. FUNCTIONING ENTERPRISE | Military unit (force element) | Doctrine, tactics, procedures | Operating environment | Force structure, commanders | Readiness sustainability | Physical manifestation of military capability as whole |



