

# The Future of Software Intensive Systems

---

## Future Complexity of Software Systems

Future complexity, future growth and higher levels of system integration are obvious for most spheres involving software – driven by user demand. The reality however is that the future contains less 'clean sheet' or "green-field" design, less ability to own the architecture of the entire system and more component system replacement in systems of systems.

This "brown-field" engineering inevitably includes mixed integrity systems and the need to 'bound' them to predictable operation, whilst improving the capability of the newly integrated system of systems. Add in a mixture of missing legacy specifications and knowledge, adaptive systems which mean 'system identification' is thwarted, and complexity approaching infinite permutations, then what techniques will we need for evidentially supporting High Integrity Systems?

Future systems may be inherently 'unprovable', but require 'layered' responses to different failures or attacks, where fail operational to a much degraded capability is much preferred. This is not unlike nature, with a 'defence in depth' approach to responding to failure (e.g. vegetation response to diverse and increasingly injurious (unpredictable) events, cuts, grazing damage, storms, droughts, infestations, viral attacks, bushfire - generally by diverse 'step-back' and 'recovery' mechanisms).

## Design and Verification Complexity

Even if we can comprehend and control the Design elements, how will we Verify these systems, collect the evidence and assure ourselves (and the regulatory bodies) that it is sufficient to meet the required demands, not just for now (as a system defined as a snapshot in time)... but for the future, with its attendant evolution of the System (where other components of the system may be undergoing change)?

## Social Dependence on Software

All this in a backdrop where dependence on software systems grows every day, for safety and security, privacy and commerce... and the users demand increasingly 'available, reliable and connected' systems, whilst our ability to assure this diminishes exponentially. Where the environment dictates that safety is no longer about mitigating 'hardware failure', but increasingly ensuring harmless interaction in the mixed domain of humans and automata; where security is no longer a response to a specified 'threat' but all possible future malicious intent (physical and virtual); where brand reputations are made (and dissolved) on 'product integrity' which is largely software defined.

## Building, Town and City Planning Analogy

In Linda Northrop's book on Ultra Large Scale Systems she makes the analogy of the future of Systems with town planning. Are there lessons we can learn? Some significant city (architectural) remodelling have served testament to long periods of stability (e.g. Paris, France - Haussmann), some of form rather than substance, but were these architects sufficiently visionary to mitigate generational changes in demand... was the destruction of the old and investment in the new well founded? London, UK demands that new buildings place no additional burden on the infrastructure resources than the buildings they replace (water, electricity, sewage etc), compartmentalising response to be mini-ecology systems... but is this a reasonable long-term strategy?

## To battle!...

What are the key attributes of these futures that our architects for tomorrow must face and mitigate... and are we ready for the fight to make that investment?