Session B4: Estimating V&V Resource Requirements and Schedule Impact

Session B4 leaders:

Co-Chairs:

Roger Logan (Lawrence Livermore National Laboratories)
David Fritz (JHU/APL).

Session Recorder: **Richard Bernstein** (JHU/APL)

B4 Materials in Foundations '02 proceedings:

Paper

Estimating V&V Resource Requirements and Schedule Impact (106 pp)
Michelle Kilikauskas (Joint Accreditation Support Activity, JASA)
Dirk Brade (Universität der Bundeswehr München, Germany)
Bob Gravitz (Aegis Technology Group)
Dave Hall (SURVICE Engineering Company)
Martha Hoppus (Joint Accreditation Support Activity, JASA)
Ron Ketcham (Naval Air Warfare Center/Weapons Division)
Robert O. Lewis (Boeing)
Michael Metz (IMC)

Slides (may contain back-up materials and notes)

Estimating V&V Resource Requirements and Schedule Impact (149 slides) [in both pdf and ppt formats]
Michelle Kilikauskas (Joint Accreditation Support Activity, JASA)
Dirk Brade (Universität der Bundeswehr München, Germany)
Bob Gravitz (Aegis Technology Group)
Dave Hall (SURVICE Engineering Company)
Martha Hoppus (Joint Accreditation Support Activity, JASA)
Ron Ketcham (Naval Air Warfare Center/Weapons Division)
Robert O. Lewis (Boeing)
Michael Metz (IMC)

Participants in this session are listed at the end of the Discussion Synopsis.

Discussion Synopsis (to provide perspective on papers & briefings identified above).

Summary Points [our observations]

OVERALL: The Power of Expressing V&V [or lack of it] Quantitatively, as:

RISK = Likelihood * Consequence

- Standard terminology of risk analysis enables fast communication

- For us, "Likelihood" ~ "Likelihood of model error"
- "Likelihood" links to a quantitative V&V process – a statement of uncertainty bound with confidence

I see two advantages:

1. The quantitative statement[s] as V&V goals[s] mean that in quantifying resources and schedule for V&V, we can point to more specific amounts of work [analyses, data, model runs] needed to achieve that quantitative statement – making our plea for resources ($$$$) more robust.
2. Since we have linked this quantitative statement to the Likelihood axis of the Risk Matrix, we can now show a VALUE of V&V in dollars, instead of "just a cost"
    a. Terms like "Return on Investment" (ROI) now have a tangible meaning for a V&V funding request!

How much V&V is enough?

There is an inference here [pun?] that adequacy is implicit in V&V. In this session, a poll was taken: "Is Adequacy part of the definition of Validation?" In other words, should we say: "Validation means stating confidence bounds on the quantity and regime of interest in a model……AND whether this is an adequately tight bound?"

The consensus was "NO, with a caveat:" In other words, the adequacy issue is at the boundary of "V&V" and "A" (Accreditation). V&V need not MAKE an adequacy statement, but the question "how much V&V is enough" is answered by saying, "enough V&V to answer the question, "From a V&V standpoint, have we done enough to accredit, and show us how we have V&V'd that the model requirements are met".

V&V of a model for a particular quantity in its regime of interest should, as *part of a minimum set,* contain a supported statement like "I am 90% confident that if I build and measure the quantity of interest, that it will fall within the confidence bands shown around the model output".

This statement means that V&V prepares us to address adequacy, and also helps define the amount of V&V to support such a quantitative statement.

When V&V is resource or schedule limited [nearly always], where to start? In our session, addressing [model] Risks in order of decreasing ROI was suggested; and with the Risk Matrix analogy, ROI can indeed be expressed in dollars, both in the benefit and the cost of V&V. In another session, a similar prioritization was suggested via the PIRT (Phenomena Importance Ranking Table) method – it is not dollar-based, but involves risk judgment prioritization just like the method presented in our session.

Adequacy, Cost, and Justification:

Often there is a "cost sticker shock" associated with V&V, if it is viewed as just a box-check. However, if it is pointed out that V&V results in a quantitative statement suitable for use in not only model but product acceptance, V&V costs can be viewed as part of a product qualification cost rather than a necessary evil.

The Cost side:

Even if we manage to quantify the benefit of V&V, we will certainly be asked how we arrived at the cost. A major part of our session was a presentation on the CET Cost Estimating Tool, available to download from the web. The demonstration showed that an experience-based, menu driven tool is available to arrive at cost estimates for Software V&V.

Cost Attribution:

Points were made that, in the process of V&V, we may reach roadblocks due to lack of information and documentation that should have been addressed during development. This part of the development process may have been skipped due to lack of rigor, lack of funds, or lack of anticipation or requirement for a subsequent V&V process. To do the V&V, this information must be provided or re-created. Somebody must bear the cost of this "retro-development" cost. Even if V&V pays for these items, they should really be attributed as development costs. We suggest that a list be made of V&V costs, but also a list of costs incurred during V&V that were more properly retro-development costs.

Data V&V:

A point stressed by several attendees is that there is a lack of attention on data validation – variability, uncertainty, and error in the data we use for V&V. Model uncertainty etc. can only be evaluated in light of knowledge of data uncertainty.

Structure of V&V:

It was pointed out that V&V consists of sets of activities (V&V per portion of code, program, model, regime, etc). Requirements should first have been laid out defining model regimes and quantities of interest, and therefore code features needed. So, a structure of order should exist such as REQUIREMENT(Quantity and Regime of Interest)---REQUIREMENT(Code feature to enable that)---CODE DEVELOPMENT(of that feature)---VERIFICATION(of that feature)---VALIDATION(that the code and relevant verified features enable us to model the quantity and regime of interest *to the desired confidence bound*).

Unless the V&V process can be ordered in this structured way, it was expressed that V&V would be like "addressing the whole Big Bang at once".

Future Research Needs:

For our session, it appeared our most pressing need was more *available* information on cost, resource, etc requirements to enable V&V agencies to come up with estimates. That is, as the CET presenter pointed out, there is a lot of cost info & studies done, but a lot of sensitivity about releasing certain parts of the info in a totally public way. Perhaps we can more easily release such information and studies of government V&V cost studies, and fold in a consistency check

with company-protected cost information while protecting the interests of the companies involved. The CET presented used such a method to contribute to the pedigree of the CET tool.

The greatest contribution our session in particular could make is to actually help V&V as a whole get more attention and funding by quantifying the benefit of V&V (as Risk Reduction ROI as presented in our session). The goal of this research should be to help quantify the relative levels of risk reduction to provide more specific information to tie risk reduction to V&V robustness.

That way, V&V proposers will have a quantified process to tell a sponsor "here is the Risk Reduction (dollar savings) you can get by funding V&V to the level we request". And, just as importantly, "here is the (dollar) Risk you may incur if you have to omit one or more pieces of the V&V process".

B4 Session Participants (22)

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