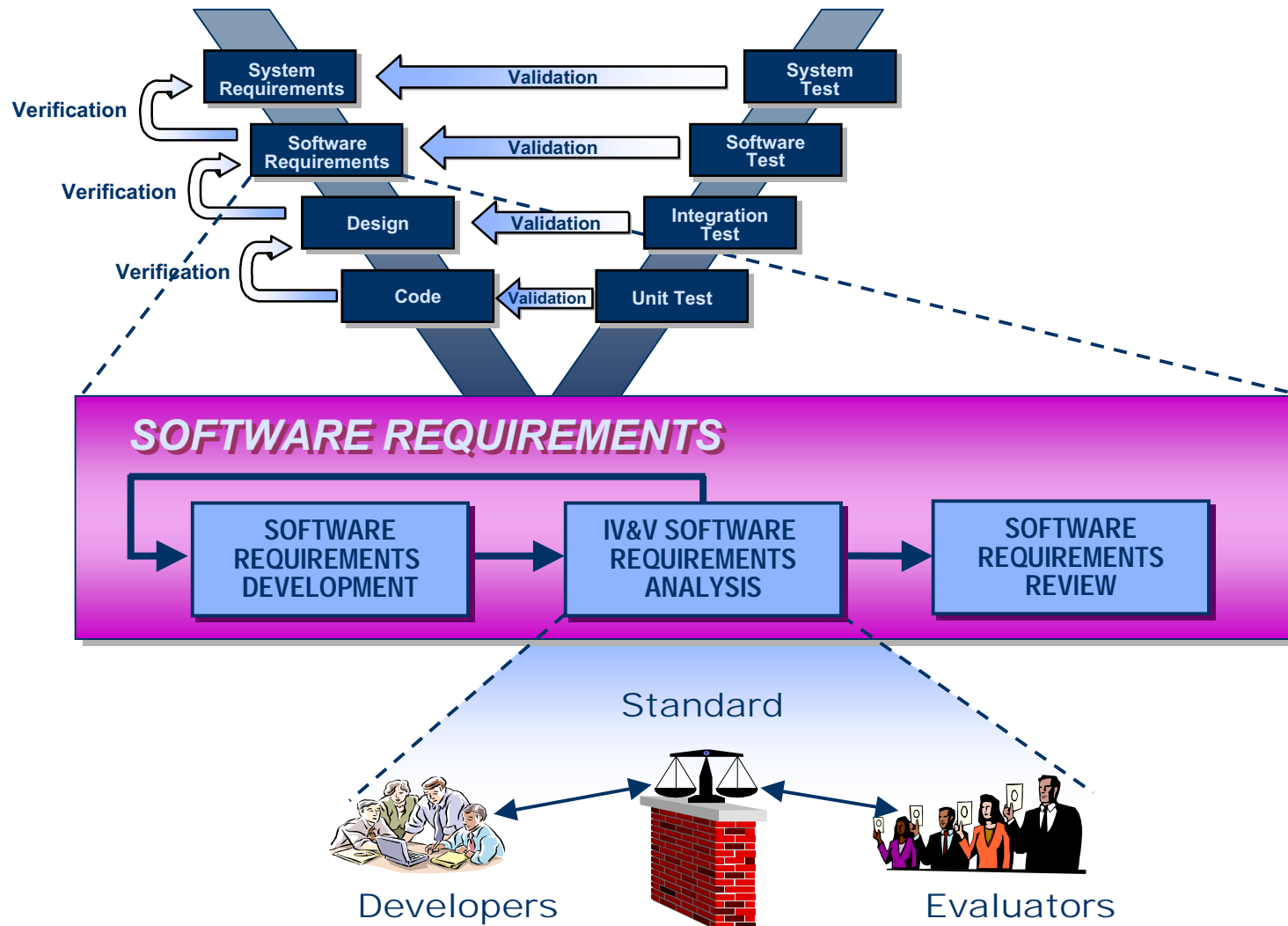




# INDEPENDENT INTEGRATED VERIFICATION AND VALIDATION (I<sup>2</sup>V<sup>2</sup>)

# INDEPENDENT VERIFICATION and VALIDATION (IV&V)



# IV&V BENEFITS AND POTENTIAL PROBLEMS

## BENEFITS

- § Early detection of defects that might otherwise remain undetected until later in the lifecycle (reduced cost and schedule)
- § Independence (technical point of view, toolset, process) allows identification of defects that could be overlooked by development personnel
- § Ensures that the delivered software will meet each baselined software requirement
- § Provides the Customer with increased visibility into software status and quality
- § Reduced maintenance cost
- § Can serve to fill the many communication holes that result from performance-based acquisition

## POTENTIAL PROBLEMS

- § Overemphasis on independence can result in non-productive, adversarial relationship between the IV&V contractor and the Development contractor
- § IV&V analyses can be out of sync with Developer internal reviews creating a separate review and rework process that can impact the development schedule
- § Not consistent with acquisition reform efforts
- § IV&V efforts traditionally not integrated with process improvement goals
- § View of the standard is often different on opposite sides of the wall

# INDEPENDENT INTEGRATED VERIFICATION and VALIDATION (I<sup>2</sup>V<sup>2</sup>)

w I<sup>2</sup>V<sup>2</sup> attempts to address the potential problems of IV&V without negatively impacting its benefits

w Goals of I<sup>2</sup>V<sup>2</sup>

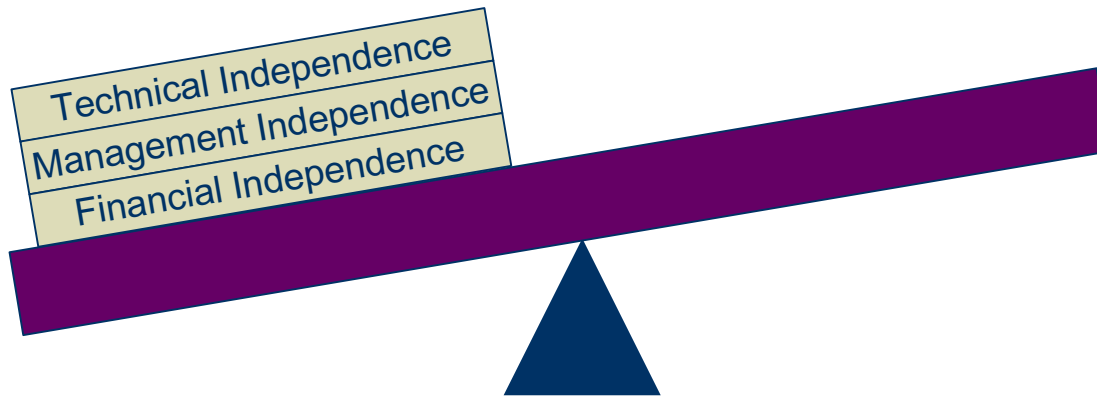
- n Reduce/eliminate the schedule impact of IV&V
- n Provide for collaboration between the IV&V Team and the Developer
- n Integrate IV&V directly into the Developer's process and process improvement program



- n Close coupling of production and inspection, reduce defect leakage
- n Eliminate adversarial relationship between the IV&V team and the Developer
- n Eliminate hidden IV&V financial conflicts

# INDEPENDENCE IN AN INTEGRATED ENVIRONMENT

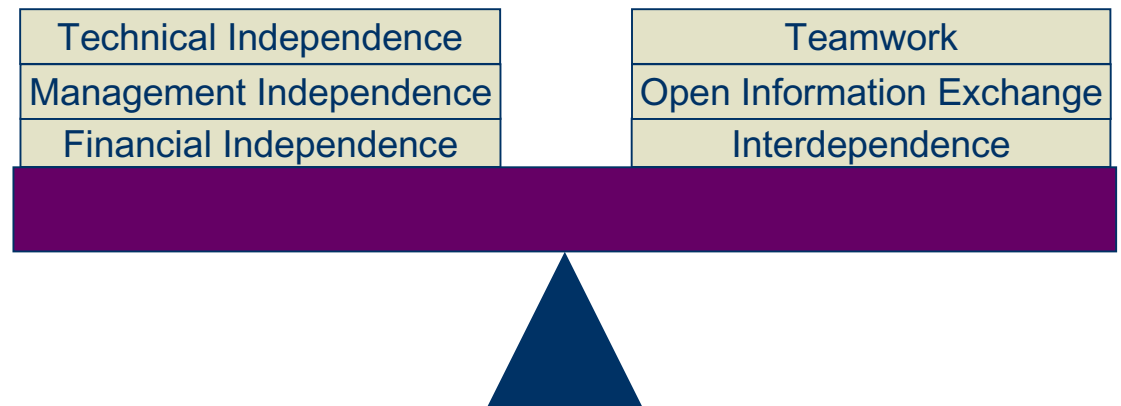
## Traditional IV&V



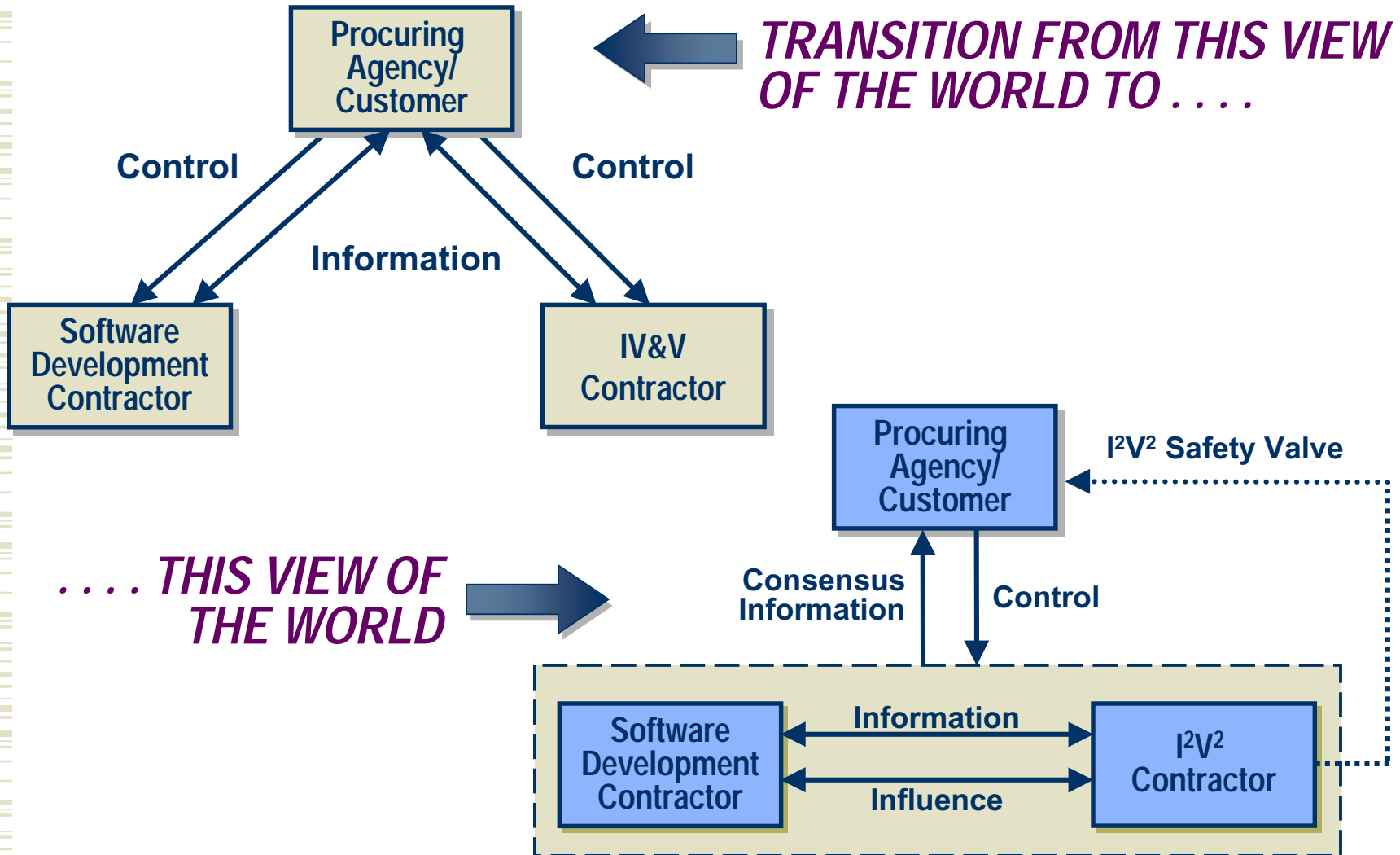
Traditional IV&V places ultimate importance on independence. Even a perception that independence is not maintained is frowned on and viewed as a weakness.

## I<sup>2</sup>V<sup>2</sup>

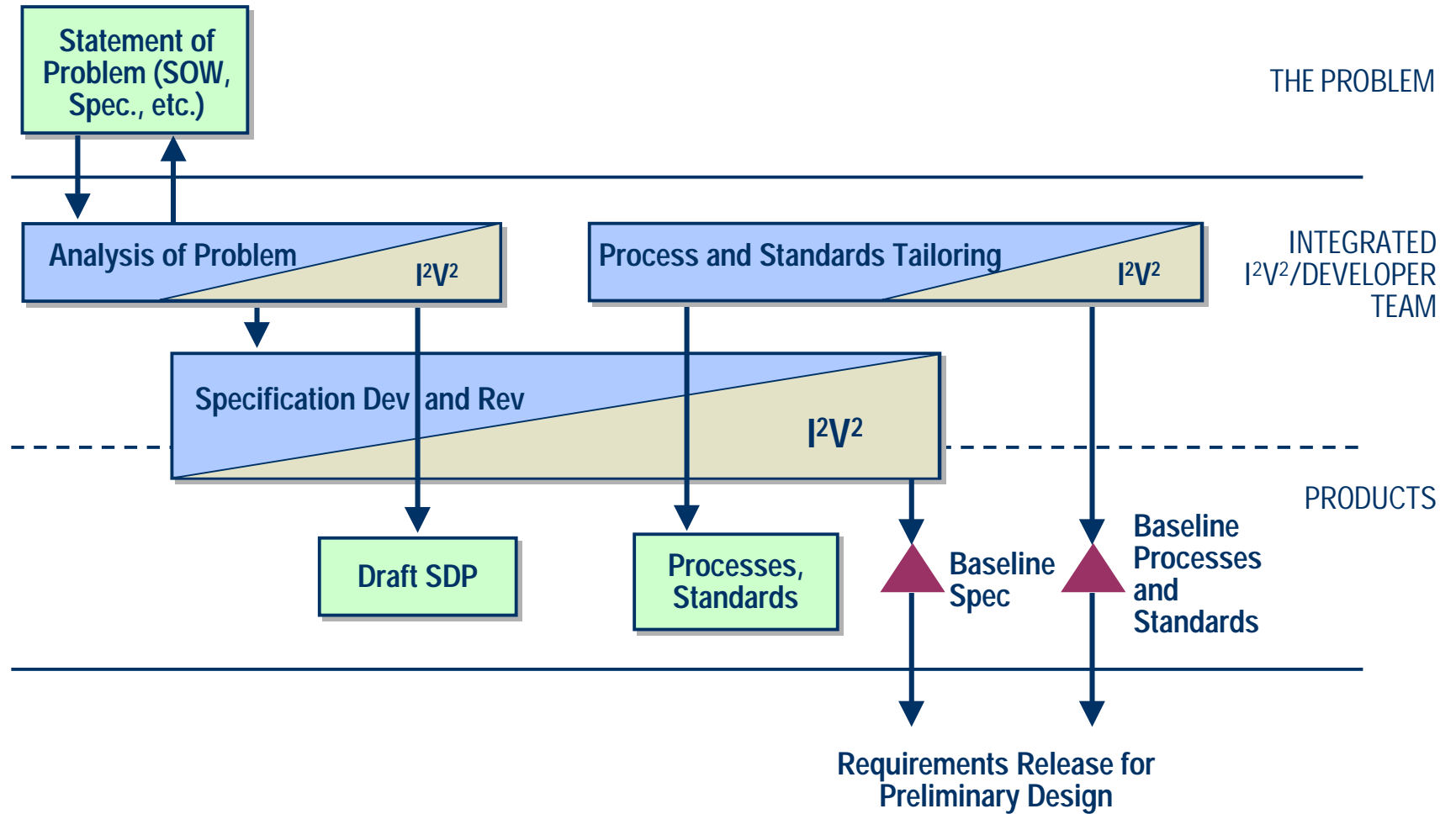
**I<sup>2</sup>V<sup>2</sup> takes a balanced approach to independence. It is willing to accept a perceived reduction in technical independence in order to gain previously discussed benefits such as open information exchange, interdependence, and teamwork.**



# OPEN COMMUNICATION AND INFORMATION EXCHANGE



# THE INTEGRATED TEAM PROCESS



## OTHER KEY PROPERTIES OF I<sup>2</sup>V<sup>2</sup>

- w Common goals and common definition of success (interdependence)
- w Integration of I<sup>2</sup>V<sup>2</sup> effort into the Developer's process
- w Participation in internal Developer reviews
- w Integration of I<sup>2</sup>V<sup>2</sup> effort into Developer's process improvement program
- w Striving for a common I<sup>2</sup>V<sup>2</sup> and Developer assessment of risks and status to Customer



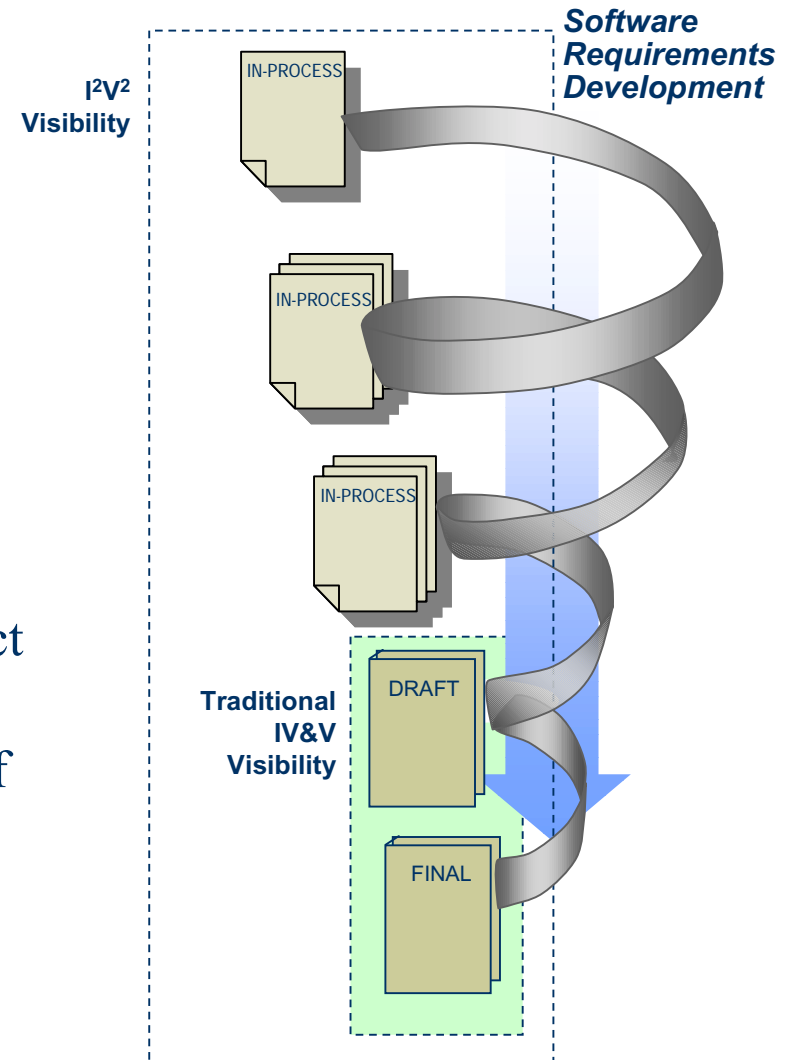
# INDEPENDENCE → INTERDEPENDENCE

- w With Traditional IV&V it is possible for the IV&V Team to succeed while a program fails
  - n The IV&V Team can succeed by identifying a large number of Developer problems (“I told you so”)
  - n The IV&V Team has no accountability for system failure
  - n This is the basis for many adversarial relationships between IV&V Teams and Developers
  
- w I<sup>2</sup>V<sup>2</sup> is built on an interdependent relationship between the I<sup>2</sup>V<sup>2</sup> Team and the Developer
  - n With I<sup>2</sup>V<sup>2</sup>, both the Developer and the I<sup>2</sup>V<sup>2</sup> Team will either succeed or fail together (achieve jointly defined objectives)
  - n If the Developer is failing, it is up to the I<sup>2</sup>V<sup>2</sup> Team to cooperatively develop approaches for resolving the associated problems
  - n In certain circumstances, the I<sup>2</sup>V<sup>2</sup> Team may assume responsibility for jointly agreed to tasks

# INTEGRATION OF I<sup>2</sup>V<sup>2</sup> INTO THE DEVELOPMENT PROCESS

## WHY INTEGRATE?

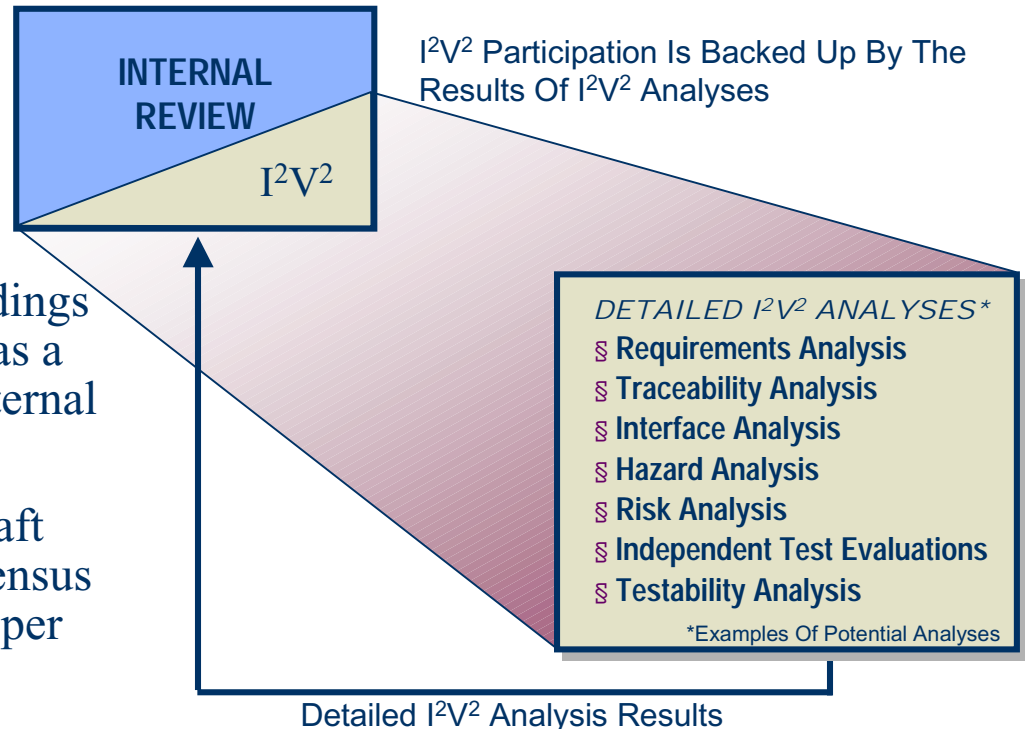
- w Recognition that development is an iterative process that starts well before the release of a draft document (planning)
- w The quality of a product is often determined by choices that are made long before the first artifact is produced
- w Take advantage of multiple opportunities for I<sup>2</sup>V<sup>2</sup> analysis and feedback prior to release of draft product
- w Supports a goal of releasing a draft document that represents a consensus of the I<sup>2</sup>V<sup>2</sup> Team and the Developer
- w Concurrence on methods of evaluation and the standards of “goodness”



# PARTICIPATION IN INTERNAL REVIEWS

## WHY PARTICIPATE?

- § Reduce schedule by eliminating a separate I<sup>2</sup>V<sup>2</sup> review and rework process
- § Earlier incorporation of I<sup>2</sup>V<sup>2</sup> findings since they will be dispositioned as a natural part of the process for internal reviews
- § Supports a goal of releasing a draft document that represents a consensus of the I<sup>2</sup>V<sup>2</sup> Team and the Developer



## ADDED BENEFITS

- At times, Developers have too many demands on their time to adequately prepare for Reviews/Walkthroughs/Inspections. They have to support multiple IPTs, Peer Reviews, and Walkthroughs, etc. while trying to find time to perform their own technical work
- I<sup>2</sup>V<sup>2</sup> analyses serve to supplement peer review comments providing developers with better feedback on their incremental products
- I<sup>2</sup>V<sup>2</sup> can also serve as a communications layer between program IPTs

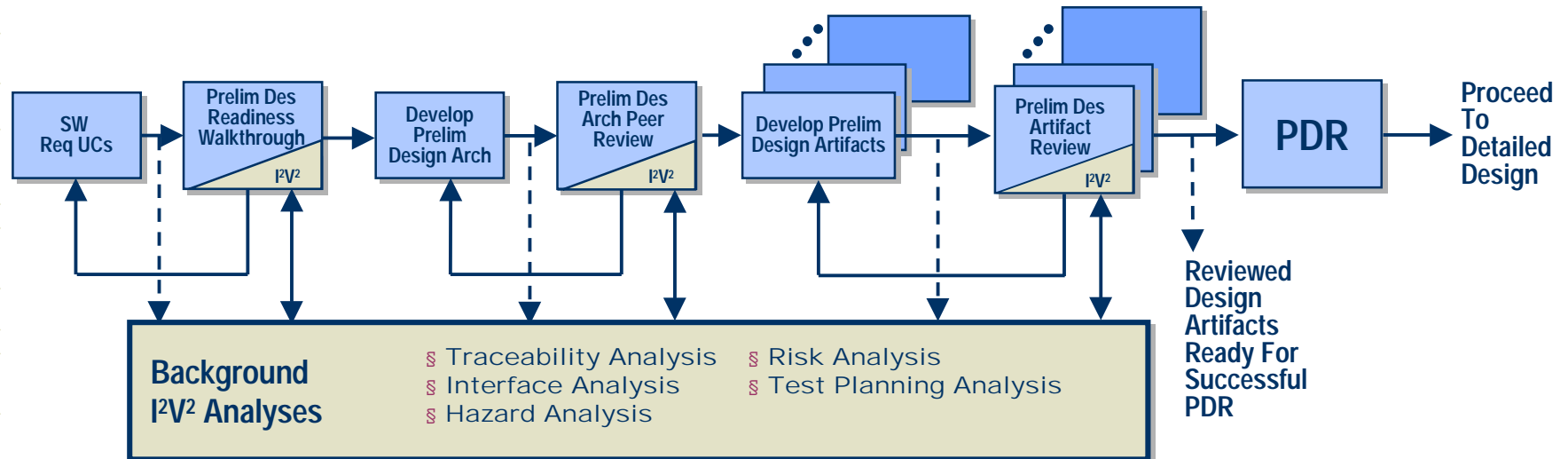
# PROCESS IMPROVEMENT

- w Traditional IV&V is focused on the detection and documentation of defects
- w I<sup>2</sup>V<sup>2</sup> recognizes that modern process definition and control techniques are critical to developing high quality software
- w I<sup>2</sup>V<sup>2</sup> can participate with a software engineering process group to provide root cause analysis for common defect types
- w Root cause analysis can be used to modify software development processes to prevent defects from being created in the first place

# PROVIDING THE CUSTOMER WITH THE DATA THEY NEED

- w With traditional IV&V, all information flowed through the Customer so lack of data was never an issue; however, often the data was not at a useful level and/or was inconsistent (Developer view versus IV&V view)
- w I<sup>2</sup>V<sup>2</sup> focuses on providing the Customer with data they need to manage the program without useless detail
  - n Direct data flow between the I<sup>2</sup>V<sup>2</sup> Team and Developer eliminates information overload for the Customer
  - n Detailed information generated during I<sup>2</sup>V<sup>2</sup> and development efforts is abstracted to provide the Customer with status assessments for key software components and key software functional areas; Green, Yellow, Red Stoplight charts provide an excellent mechanism for such assessments
  - n Action plans are provided to address items with Yellow or Red assessments
  - n Whenever possible, the status assessments are presented as a consensus position of the I<sup>2</sup>V<sup>2</sup> Team and the Developer eliminating inconsistent data inputs to the Customer that forces them to arbitrate between two conflicting views

# I<sup>2</sup>V<sup>2</sup> - PUTTING IT ALL TOGETHER (PRELIMINARY DESIGN EXAMPLE)



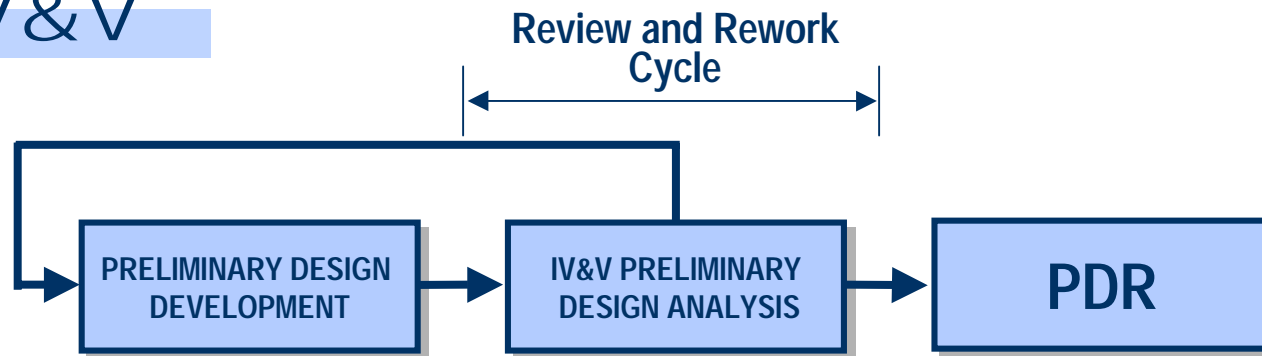
**Independent Integrated Verification and Validation (I<sup>2</sup>V<sup>2</sup>) is the application of an IV&V process integrated within the software development process. The I<sup>2</sup>V<sup>2</sup> team actively participates in all aspects of the software process in order to detect and resolve errors before they are captured in deliverable products.**

# COMPARING I<sup>2</sup>V<sup>2</sup> TO IV&V (PRELIMINARY DESIGN EXAMPLE)

I<sup>2</sup>V<sup>2</sup>



IV&V





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## SOME IMPLICATIONS OF $I^2V^2$

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w Rapid  $I^2V^2$  analyses

w Challenges and limitations



# RAPID I<sup>2</sup>V<sup>2</sup> ANALYSES

- w Background I<sup>2</sup>V<sup>2</sup> analyses can provide incremental analysis results to support quick response internal reviews
- w Focus quick response analyses to reduce analysis time; focus based on:
  - n Anticipated problem areas based on past experience
  - n Known problem areas based on earlier analyses
  - n Risk Analyses
- w Use tools to automate and speed up analyses
  - n Developer Tool Set
  - n V&V Tool Set
  - n Microsoft Tool Set (otherwise known as Office)



# CHALLENGES AND LIMITATIONS

- w Must get “buy-in” from all parties (Developer, Customer, I<sup>2</sup>V<sup>2</sup> Analysts)
- w Must have trust and honor in all parties
- w Must clearly define roles and responsibilities of the I<sup>2</sup>V<sup>2</sup> Team versus that of the Developers to avoid conflicts
- w Success has to be defined as a win-win-win proposition
- w Strong interpersonal skills are a must for all parties
- w Must have highly skilled I<sup>2</sup>V<sup>2</sup> analysts
  - n Developer will never enter into this close relationship with technically inferior analysts
- w I<sup>2</sup>V<sup>2</sup> analysts may need to co-locate at Developer site
- w Analysis can only find so many problems
  - n I<sup>2</sup>V<sup>2</sup> analysts must realize that they are products of their past experience

# I<sup>2</sup>V<sup>2</sup> EXPERIENCE



- w I<sup>2</sup>V<sup>2</sup> Teams successfully participated in two recent Army software development programs
- w I<sup>2</sup>V<sup>2</sup> supported Developer process improvement initiatives transitioning from CMM Level 1 to Level 4 over a seven year period
- w Met all key schedule dates under program control
- w Successful IOT&E and multi-year production awards
- w Cooperative Research and Development Agreement (CRDA)
- w Nominated to Crosstalk as one of Government's top five software projects
- w I<sup>2</sup>V<sup>2</sup> Team provided a built-in surge capability for the program

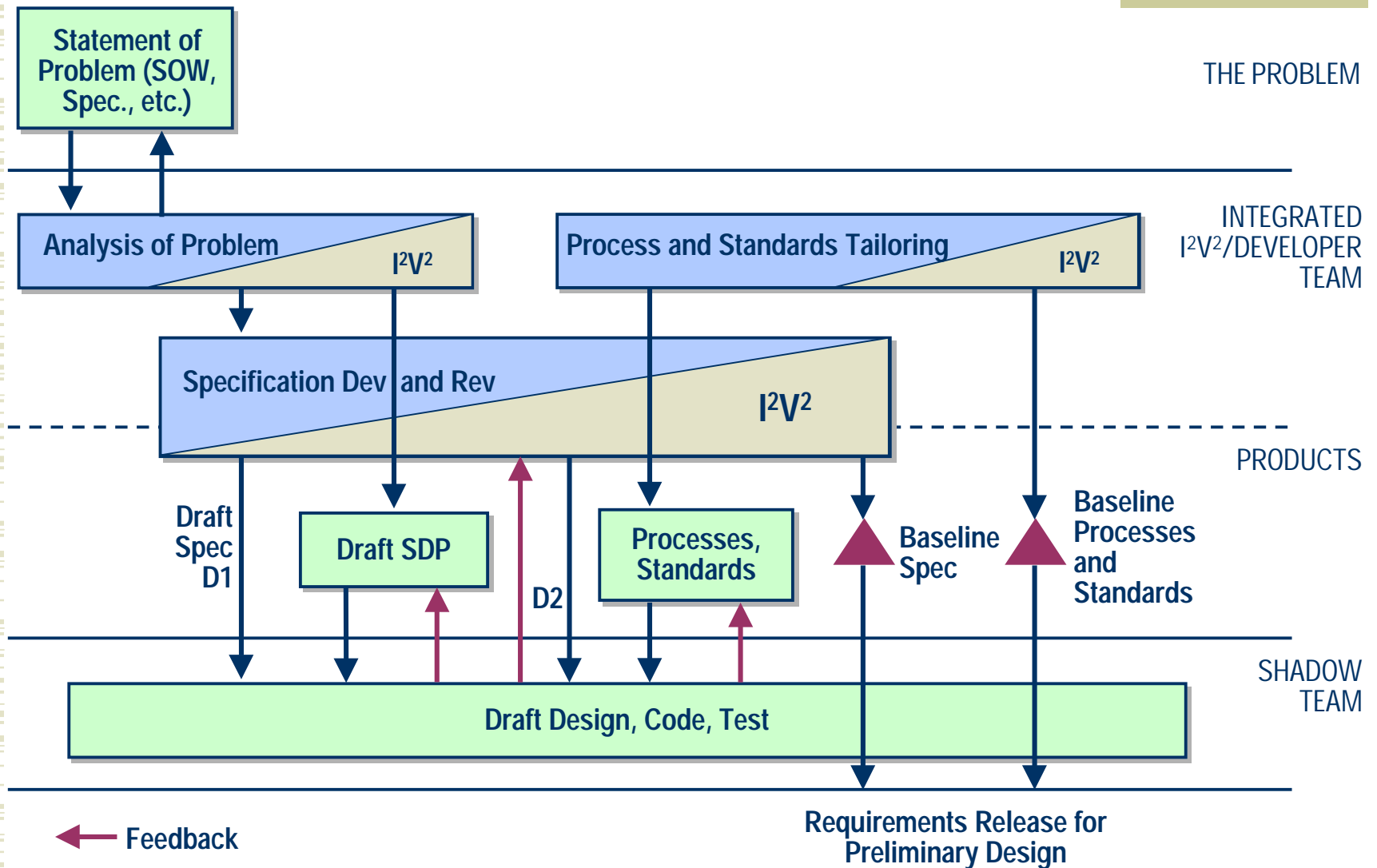
# I<sup>2</sup>V<sup>2</sup> - A PROPOSED EXTENSION

- w IV&V often uses artifact analysis to predict downstream problems (e.g., if requirement X isn't traced to the design, it won't be implemented)
  - n Analysis is heavily based on past program experience
  - n Difficult to recruit qualified, experienced staff to do analysis
  - n Ignores data or knowledge not in IV&V documentation domain
- w I<sup>2</sup>V<sup>2</sup> could be supplemented by a “shadow” development team working 1-2 process phases ahead of main development
  - n Personnel from Developer and I<sup>2</sup>V<sup>2</sup> team members
  - n Verify the analytical “predictions” correctness
  - n Tune the analysis methods by flowing findings back to main development team
  - n Detect problems not found by analysis (e.g., unplanned test tools)
  - n Refine/validate downstream process and standards (e.g., unit testing)

# I<sup>2</sup>V<sup>2</sup> - A PROPOSED EXTENSION (Continued)

- w Demonstration/Prototype Products
  - n Most programs rely heavily on these for customer assessment
  - n Often done with totally different processes
  - n Having I<sup>2</sup>V<sup>2</sup> members on these teams could greatly benefit program
    - 1 Potentially allow for releasable products for certain uses
    - 1 Tune the I<sup>2</sup>V<sup>2</sup> analysis to focus on actual versus theoretical problems
    - 1 Recruit and retain better I<sup>2</sup>V<sup>2</sup> staff
    - 1 Allow for more research on cooperative rapid prototyping
- w Early detection of integration problems
- w Validation of artifact quality and usefulness
- w Risk reduction
- w Faster maturation of software

# THE INTEGRATED TEAM PROCESS (WITH SHADOW TEAM)



# CONCLUSIONS

- w IV&V is an effective/proven methodology
- w Where workable, I<sup>2</sup>V<sup>2</sup> provides a refinement to the IV&V process that addresses aspects of IV&V that have presented problems in the past
- w I<sup>2</sup>V<sup>2</sup> meets much of the definition of independence without the barrier to communication of “the wall”
- w The right team members and managers are needed
- w Offers an alternative that addresses declining use of rigid standards

# I<sup>2</sup>V<sup>2</sup> - WHERE DO WE GO FROM HERE?

- w Article is currently in work to provide a more detailed discussion of the key elements of I<sup>2</sup>V<sup>2</sup>
- w Written I<sup>2</sup>V<sup>2</sup> procedures to be generated in parallel with application on future programs
- w Proposing the addition of I<sup>2</sup>V<sup>2</sup> as a named V&V form in the next update of IEEE STD 1012-1998 (nothing in the current version of the standard precludes I<sup>2</sup>V<sup>2</sup>)
- w Future project to develop a tutorial if there is sufficient interest in the I<sup>2</sup>V<sup>2</sup> concept



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