The Network-Enabled Verification Service (NEVS)
Integrating Data to Support User-Specific Verification

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Core Problem

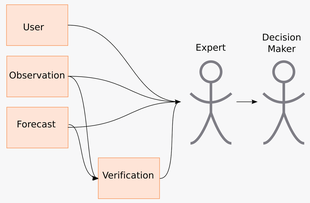
The goal of NEVS (Network-Enabled Verification Service) is to

- facilitate meaningful analysis and comparisons amongst verification datasets from disparate sources
- facilitate verification analysis within a user-specific context, without imposing unrealistic or unnecessary constraints on the sources and organizations involved

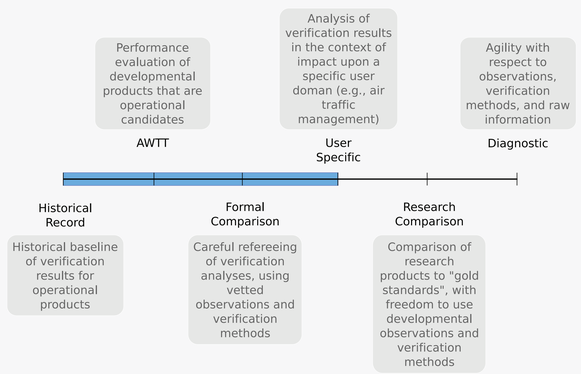
NEVS systems will provide real-time, operational infrastructures to support this goal.

Requirements Spectrum

The general use of NEVS will be for decision support. The decisions made may range from moving a developmental forecast product into operations, to heavily weighting a particular forecast in the management decisions of airspace. All cases will involve presentation of verification results, verification analysis, resulting decisions, and feedback from the user.

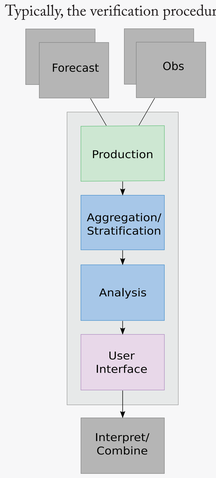


The types of analysis performed via NEVS can be represented as a spectrum, ranging from viewing the performance of a product from a historical standpoint, to a more diagnostic evaluation. Below are the major user categories with our main focus in the area highlighted in blue:



Historical Approach

Typically, the verification procedure comprises the following steps:



- Production of verification vectors: Associate the forecast and obs spatially and temporally
- Aggregation/stratification: Summarize the verification vectors into categories specific to a particular type of analysis (e.g., contingency tables)
- Score: Calculate statistical measures (e.g., POD)
- View/analyze results

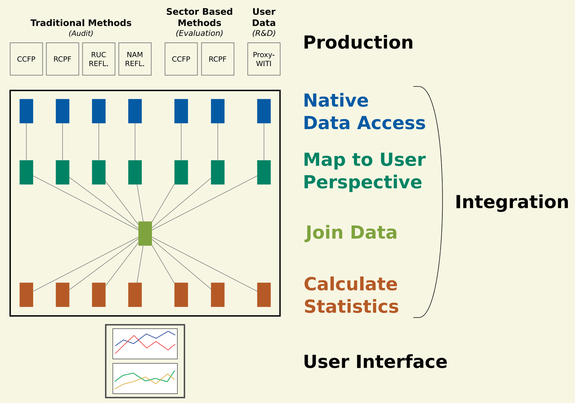
Our historical software development approach has been a "stovepipe" approach, where a single line of processing controls the entire verification procedure, from verification vector production to verification analysis, with the resulting data strongly tied to a particular user interface.

Drawbacks:

- Integration with other data typically done as manual post process
- Constrains points of integration
- Leveraging individual processing components within the pipeline without duplication is difficult
- The addition of new (or changes to existing) verification procedures is time-intensive and invasive

Proof of Concept

- This proof of concept exercises the NEVS design with a focus on the management and integration of verification and user data in user-specific context of air traffic management
- For further background on the verification and user domain concepts see Kay et al. 2008



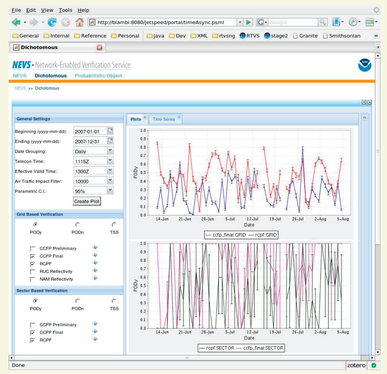
The diagram illustrates the core layers of the NEVS design. The specific datasets in the diagram are taken from existing verification production tools (as illustrated in Use Case I).

The key areas of the design are as follows:

- Separation of verification processing into three major layers:
  - Production of traditional dichotomous verification statistics, both with grid-based and sector-based perspectives, as well as a weather impact measure
  - Integration of the data to facilitate comparison of the forecasts in light of the user perspective which includes strategic teleconference decision points and understanding of aviation impact
  - Web interface allowing users to explore the data, including days, times and impact thresholds of interest
- The integration of the data can be further decomposed into four stages:
  - Optimized access of the native datasets (those provided by the data producers)
  - Mapping from the native data domain to the user perspective
  - Joining datasets within the user's domain
  - Further summarization and statistic calculation

Screen Shots

Use Case I - Extending traditional verification applications

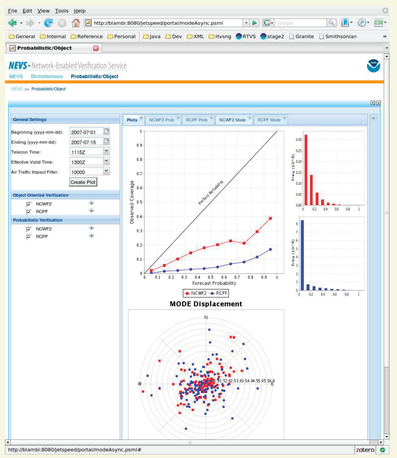


Traditional verification features:

- Subsetting of data based on date and time
- Intercomparison of multiple products
- Select among various statistics for comparison
- Provide confidence intervals on statistics of interest

In addition the NEVS concept allows for easy extension of the traditional verification paradigm:

- Incorporating the concept of air traffic telecon and effective valid times, thus equalizing and comparing products based on user application rather than forecast production attributes
- Filtering the data by a user domain attribute, in this case a weather/traffic impact measure
- The introduction of the sector-based dichotomous statistics allows not only reporting of this user-specific stratification and verification approach, but also allows the comparison of traditional grid-based approaches with new sector-based methods



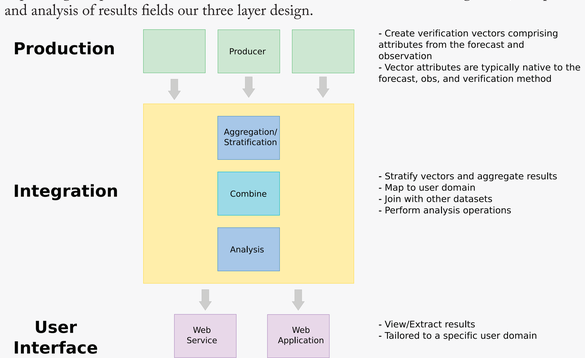
Use Case II - Facilitating new verification applications

The NEVS concept can also be utilized to build emerging verification applications. This example presents probabilistic and object oriented verification methods in a unified view that ensures the datasets:

- Conform to the user viewpoint
- Are equalized
- Are filtered along the same user supplied criteria

New Approach

Separating the production of verification information from the data management, comparison, and analysis of results fields our three layer design.

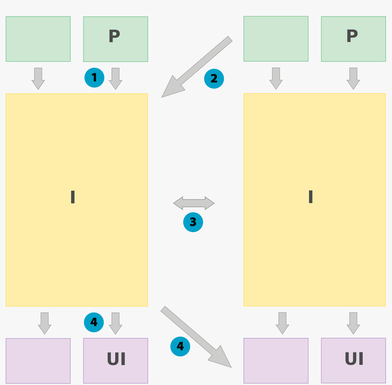


Benefits

- Leverage same processing components for multiple domains
- Easier to incorporate new products and change existing processes
- Facilitates an automated combination of data from different sources

Collaboration Opportunities

The NEVS infrastructure enables a more complete view of forecast quality by integrating data from many sources. Collaboration between verification producers, integrators and consumers is an opportunity to broaden perspective when verifying forecast products, resulting in a more comprehensive view of forecast quality.

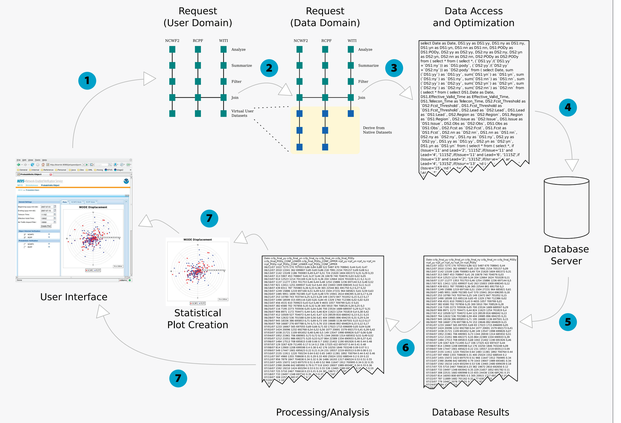


Opportunities for collaboration within the NEVS framework are as follows:

1. Run third-party verification production tools locally to feed the integration layer
2. Import data from third-party verification production tools run remotely
3. Share verification data directly from compatible remote integration layers (This interchange is the preferred method over 1 and 2 when other pressures are equal)
4. Supply synthesized verification data as a service for local and remote applications

Engineering Highlights

The principal challenge in developing the Integration Layer within the NEVS framework is communicating and efficiently fulfilling a request from an user's viewpoint. The diagram below illustrates the major steps in the process of satisfying these requests.

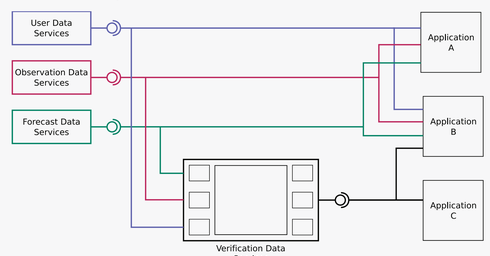


Starting from the user interface at the left,

1. A request in the user domain is formed
2. The user domain request is translated into a request within the data domain. This translation maps the user's viewpoints to those of the native data domain
3. The data domain request is translated into data access and processing operations and optimized for performance. At this step, the Integration Layer must identify which data access and processing operations may be performed by the storage engine (a relational database in this case) and which operations must be performed within the Integration Layer
4. Storage engine data access and processing
5. The storage engine returns the results of its access and processing operations
6. Additional processing operations are applied within the Integration Layer to these results
7. The final results are returned to the user interface for plot creation and display

Services

Service oriented architectures (SOA) are being proposed and evaluated at many levels within NOAA and the FAA. The principal strength of SOA is the ability to more rapidly meet end user needs by sharing and leveraging existing services. In light of this understanding the following is a discussion of how NEVS can participate within these future infrastructures and contribute to better user-specific solutions.



- NEVS will utilize services that provide forecast, observation and user-specific data
- NEVS will provide verification data to other services and/or user-specific applications
- The NEVS team will implement and refine standards defined within these organizations
- NEVS will provide tunable performance, enabling the satisfaction of a broad spectrum of user application requirements

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