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US NDC Modernization Project Expert Review Panel Report

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Abstract

AFTAC and the SNL US NDC modernization project team hosted a two-day expert review panel meeting September 30th & October 1st, 2014 to solicit input from subject matter experts regarding the technical direction and current design concepts proposed for the modernized US NDC system. This report documents the panel's recommendations captured during the review.

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1. OVERVIEW

AFTAC and the SNL US NDC modernization project team hosted a two-day review panel meeting September 30th & October 1st, 2014 to solicit input from subject matter experts regarding the technical direction and current design concepts proposed for the modernized US NDC system. The panel review was conducted as a risk reduction activity to ensure that the project's analysis and design efforts do not overlook important ideas that could significantly affect the emerging architecture. This report documents the panel's observations and recommendations captured during the review.

2. PANEL MEMBERS

Name	Organization
Kvaerna, Tormod	NORSAR
Harris, David	DSP
Benz, Harley	NEIC
Tomuta, Elena	CTBTO
Schult, Rick	AFRL
Walter, William	LLNL
Dodge, Doug	LLNL
Begnaud, Mike	LANL
Stead, Richard	LANL
Rowe, John	SNL

3. OTHER ATTENDEES

Name	Organization
Poffenberger, Alan	AFTAC
Wehlen, Joseph	AFTAC
Junek, William	AFTAC
Ichinose, Gene	AFTAC
Pope, Brian	AFTAC
Vandemark, Tom	AFTAC
Woods, Mark	AFTAC
Dwyer, John	AFTAC
Stutzman, Ryan	AFTAC
Burns, Shack	SNL
Harris, Mark	SNL
Prescott, Ryan	SNL
Young, Chris	SNL

4. ACKNOWLEDGEMENT

The panel wishes to thank the organizers for the invitation to participate in the review and especially the opportunity to provide our inputs, observations and recommendations for consideration. The read-ahead material provided to the panel was quite beneficial, particularly for those members having less familiarity with the details of the current system and on-going modernization effort. And the briefings presented to the panel during the review provided addition insights into the progress and challenges facing the USNDC modernization architecture team.

Moreover, the panel members were delighted to be offered time during the review to make short presentations to the USNDC modernization team, and their sponsor participants, that highlighted specific areas of interest or concern that we felt would be important to consider as the program moves forward.[1] We believe the ensuing dialogue was extremely beneficial to all concerned and helped the panel crystallize the specific recommendations that follow.

Lastly, the panel would be honored to participate in a follow-up review, near or at the conclusion of the USNDC modernization architecture study.

5. PANEL PRESENTATIONS

The following briefings were presented by members of the panel and other attendees during the meeting:

1. *Leveraging US NDC and IDC Modernization* (Alan Poffenberger, AFTAC)
2. *US NDC Modernization Status* (Joseph Wehlen, AFTAC)
3. *US NDC Modernization Project Overview* (Mark Harris, SNL)
4. *Modernized US NDC Expert Panel Architecturally Significant Use Cases* (Shack Burns, SNL)
5. *The Next Generation of Data Flow at USGS National Earthquake Information Center* (NEIC) (Harley Benz, NEIC)
6. *Shortcomings of the Current System* (Richard Stead & Mike Begnaud, LANL)
7. *US NDC Modernization and IDC Reengineering* (Elena Tomuta, CTBTO)
8. *US NDC Modernization* (Rick Schult, AFRL)
9. *Some Thoughts on US NDC Modernization* (William Walter, LLNL)
10. *Large-Scale Correlator Deployment in Global Pipelines* (Doug Dodge, LLNL)

[1] These panel presentations and comments were captured by the USNDC modernization team as PowerPoint briefings and summarized in the review minutes.

11. *Conjectures on Pipeline Architecture* (Dave Harris, DSP)

12. *Considerations Regarding a Modernized US NDC* (Tormod Kvaerna, NORSAR)

13. *US NDC Modernization Project Observations* (John Rowe, SNL)

6. PANEL RECOMMENDATIONS

1. **The US NDC modernization project should establish key performance requirements to be addressed by the modernized system, based on future projections for the mission. Rationale: many of the requirements presented address functional and design attributes, and while important, they are not sufficient to ensure that the resultant architecture will provide the capacity and/or expandability needed to meet the needs over a 20+ year time horizon. Example performance factors include, but are not limited to, the following:**
    a. The number of stations
    b. Anticipated magnitude thresholds
    c. Reporting timeliness
    d. Responsiveness
    e. Throughput volume (e.g. GB/day)
    f. Event processing capacity
        i. The project should consider specifying separate performance requirements for nominal and surge conditions, accounting for predicted network density and monitoring thresholds
        ii. The project should consider specifying separate performance requirements by processing mode (e.g. bulletin processing and event analysis modes)
        iii. The project should account for both US NDC and IDC performance requirements
            1. IDC constraints may influence architecture decisions and must be reviewed with CTBT member states (cannot be decided unilaterally)
            2. The IDC must be prepared to accept data that are contributed by member state NDCs, which could significantly increase required processing capacity beyond the primary IMS network

2. **The system architecture should support heterogeneous, iterative processing algorithms, specialized by station and source region. Rationale: as the number of stations increase and improve in capability, there will be a natural and possibly exponential increase in the amount of data and/or number of events observed, which will challenge the system and its operators in maintaining their ability to detect and characterize specific events of interest (e.g., finding the needle in haystack)**

3. **The system should, to the extent practical, provide the characteristics listed below. Rationale: due to the expected 20+ year life of the system, multiple recapitalizations and upgrades are anticipated to address obsolescence issues and/or mission needs; systems with the recommended attributes are less risky and less costly to sustain and improve, and in particular the ability to plan for supporting and integrating continued R&D is key to maintaining relevance.**
   a. Modularity
      iv. The system should be designed for loose coupling of components (e.g. based on language-agnostic messaging interfaces) in order to minimize complexity in integrating new components
      v. The system should be designed to facilitate incremental recapitalization of software and hardware
      vi. The system should support processing hierarchies - e.g. including local, regional and global processing pipelines
      vii. The system should support iterative, multi-pass processing approaches
   b. Interface Standardization
      i. The system should use published interface standards for
         1. Software & data product interfaces
         2. Waveforms and parameters
         3. Geophysical model interfaces
         4. Common means to set, retrieve and track software runtime configuration settings and options
      ii. The system should use external system interface standards (e.g. data exchange standards) that are accepted by the community
      iii. The system should use internal interface standards to facilitate interoperability between subsystems
      iv. System interfaces should support integration of independently developed system components implemented in the development languages defined for the modernized system
   c. A means for programmatic policy feedback (i.e. – Provide a method for timely programmatic review of the design that might influence future design decisions)
   d. A means for research community access to the system and feedback on system capabilities, as well as a clear path for integration of new algorithms, models, parameters, etc.
      i. Research community support should include a high-fidelity test environment and access to the full set of historical US NDC data

4. **To aid researchers in their work to improve monitoring capability, the system should support dynamic integration (e.g. without recompilation) of new system components, libraries, etc. Rationale: easier to sustain/improve.**

5. **To the extent practical, the modernization project should evaluate and leverage current & emergent technology trends. Rationale: better price/performance, generally easier to sustain/upgrade; however, with respect to COTS software special care must be taken in evaluating the short-term advantage against the potential long-term risk (e.g., obsolescence/lack of support) for any key embedded system element.**
    a. Architecture trade studies should be conducted to identify leveraging opportunities and candidate technologies
    b. Key purchased elements should be layered/isolated to reduce risk associated with the need to replace them
    c. On delivery, the system should not include any technologies unproven for critical operations, but should not exclude the direct integration of such technologies when they are mature.

6. **The system should provide significantly improved support (e.g. user interface support) for analysis of events under surge conditions (e.g. aftershocks). Rationale: aftershocks present very large numbers of events in a relative short period of time that may overwhelm the operators.**

7. **The system should exploit the large archive of full waveform and rich parametric information available at the US NDC:**
    a. For detection of events, e.g. using waveform correlation and matched field array processing
    b. For analysis of events, e.g. by overlaying information from similar historic events

    Rationale: Research by the US NDC as well as other organizations has demonstrated that direct use of this type of information can dramatically improve the completeness, quality, and timeliness of the event bulletin.

8. **The US NDC/IDC project team should consider how to further engage CTBT member states in the analysis and design of the joint IDC reengineering/US NDC modernization project. Rationale: opportunity to leverage the community to provide better collective solution.**

9. **The US NDC project team should provide the following minimum information in the artifact set delivered at the end of the elaboration phase. Rationale: multiple artifacts, providing different views into the system characteristics, are needed to evaluate efficacy of the architecture and reduce development risk.**

a. Operational overview of the system (e.g. OV1)
b. All external interfaces identified, and where practical, interface content documented
    i. Including changes required to the current physical data model
    ii. Including specifications for programmatic access to the system using the COI (or any alternative interface that comes out of elaboration).
c. System views addressing all subsystems (including SW, HW, deployment, etc.)
d. Proposed OPSCON
e. Mapping from requirements to the system views
f. Key trade studies that are deferred until the development phase
g. Risk assessment
h. Transition plan addressing incremental deployment of the modernized system

10. **The system should, to the extent practical, provide support for the improved CSS format that will be developed as part of IDC reengineering. Rationale: data exchange with the community at large.**
    a. The project should, to the extent practical, address consolidation of data formats (FDSN)
    b. The project should, to the extent practical, address standardization of station metadata

11. **The system should, to the extent practical, support advanced human interaction techniques. Rationale: the next generation(s) of operators will have a fundamentally different computing/gaming experience base and perspective on how to interact with a human-in-the-loop system than their predecessors; furthermore, additional demands placed on humans from significantly increased data/event rates could render the system ineffective if not addressed.**
    a. E.g. gesture & touch controls; also more dynamic, interactive interfaces such as joystick controls for waveform filtering, etc.
    b. The user interface should be tailorable by user role
    c. The user interface should support waveform comparison (e.g. overlay or side-by-side, including historical comparison)

12. **The system should capture provenance of system data inputs and products. Rationale: traceability, repeatability.**
    a. E.g. history of processing decisions, parameters, etc.
    b. The system should capture the origin of all external data, whenever possible, and to the specificity practical - e.g. a specific line of a specific document and the source of said document

c. The system should also provide, to the extent possible, for full error descriptions tied to all measurement values
d. For geographic data of external origin, the system should always capture the original geodetic datum information
e. System should, to the extent practical, capture system performance and usage statistics such as number of times a certain operation is performed to produce a result, how long certain operations take in processor time and wall clock time, etc.

13. To the extent practical, domain experts should be involved in all phases of the project (including the system development phase) in order to reduce execution risk. Rationale: leveraging multiple perspectives and a broader experience base has been shown to reduce the risk of complex systems development.

a. The project should embed domain experts in the development team
b. The project should review lessons learned from analogous systems (e.g. the NEIC) and similar historical systems
c. The project should conduct trade studies as needed to identify development lifecycle processes to be followed during the development phase

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