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# International Council of System Engineers (INCOSE)

**Model Based System Engineering Working Group**

# Call for Participation

# Response for GEOSS Architecture Implementation Pilot – Phase 3

# (AIP-3)

# March 3, 2010

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# Overview

The GEOSS Unified Modeling team engineering effort will update AIP-2 View Enterprise, Information and Computational View Diagrams in order to add emerging requirements and more detailed data, develop new Enterprise, Information, Computational and Engineering View diagrams required for New Scenarios being introduced in AIP-3 effort and prepare the Engineering and Technical Views for the AIP-2 scenarios after the Enterprise, Information and Computational Views have been completed. All views constructed will be built in compliance with Reference Model of the Open Distributed Processing (RM-ODP) viewpoint using the Unified Modeling Language as well as the System Modeling Extension (SySML) as the syntax. This will be done by expressing each scenario of the proposed Nine AIP-2each GEOSS Societal Benefit Areas (SBAs)/scenarios in five viewpoints as described in ISO/IEC 10746:1996 Part 3 Reference Model Open Distributed Processing (ODP) Architecture and description of the UML concepts and extensions provided in ISO/IEC 19793:2007

The objective of this effort will be to update the Enterprise, Information and Computational view products currently in the GEOSS architecture from AIP-2 for each of the nine scenarios of the Societal benefit Areas (SBA). The Enterprise views will be updated to include Roles and Policies (Business Rules) for each scenario and its use cases. We will also develop the UML/SySML diagrams for each new AIP-3 required SBA/Scenario based on the Enterprise/Information, Computational views, and Engineering and Technical views. We will work closely with SBA teams to allocate all services and system functions to match updated and new SBA/scenarios.

# Proposed Contribution

## 2.1 Architecture and Interoperability Arrangement Development

The INCOSE Team efforts will be concentrated on updating the Enterprise, Information and Computational views built for the nine scenarios developed in AIP-2. We will also add Policies for each of the nine scenarios. These will be developed by interviews and discussions with each scenario team.

The INCOSE team will then work with the five new scenario teams to develop the Enterprise Views including Use cases and use case Diagrams, roles, and policies. We will then develop the Information, Computational, Engineering and Technical Views in accordance with ISO/IEC 10746:1996 Part 3 Reference model and ISO/IEC 19793:2007 standards.

Major Deliverables will include documentation of the results of the AIP Phase in Engineering Reports regarding the scenarios and all five views of the architecture as defined in the ISO/IEC 10746 and 19793 standards.

#### 2.1.1 Comments and contributions to the GEOSS AIP Architecture.

The INCOSE AIP 3 response team will provide comments and contributions via the GEOSS Pilot Home Google.com web site [https://sites.google.com/site/geosspilot2/Home](https://sites.google.com/site/geosspilot2/Home%20). We will post to this sites and discussion page, Societal Based Area (SBA) Working group, Transverse Technology Working group and post Enterprise Modeling SBA scenario based ISO/IEC 19793 UML/SySML View diagrams and Engineering Reports as required. We will also post via outreach any outside collaboration activities and results. The INCOSE has experience using this GEOSS Pilot Home as a result of our participation in AIP-1 and 2. We will also set up a workspace on the GEOSS Pilot site. We will also consult the OGC Network <http://www.ogcnetwork.net/AIP2develop> at least weekly to review input regarding AIP-3 activities. We will send a representative to each of the SBA and Transverse Working Group meetings to provide and obtain data regarding construction of the five architecture views and provide subject matter expertise to the SBA WGs as to use of the UML syntax.

#### 2.1.2 Plans for participating in the AIP System Design process as defined in the AIP Development process referenced in the CFP.

#### 2.1.2.1 Scenarios

We will attend weekly scenario team meetings and provide inputs regarding the use of UML syntax and building of Enterprise diagrams and build the use Case and Activity Diagrams, state and sequence diagrams as well as collaborate in the selection and writing of policies.

#### 2.1.2.2 Enterprise Models

The enterprise viewpoint describes the business requirements for the Air Quality management and decision support using GEOSS-2 without specifying the technology or other system considerations.

The Enterprise View defines use cases for Air Quality, using Object Management Group's Unified Modeling Language (UML). The sections that follow the Overview Use Case Diagram are organized by use case and describe the series of processes for each of the use cases. The processes are defined by activity diagrams; our example is currently limited in scope to only the Wildfire scenario from AIP-2.

A use case diagram describes the behaviors and dynamics of the system being modeled, and is composed of a component boundary, use case name, external actors and their relationships. Within the use case diagram, actors are represented as person stick figures, and use cases are shown as bubbles.

The following diagram Figure 1 presents and the overview use case diagram for Air Quality scenario. It identifies the use cases that comprise air quality management and decision support using GEOSS-2 and the high level relationships between them.



Figure Overview Use Case Diagram

Actors will be used to formalize the *roles* of systems, individuals, or external components which interact with this system. The following example table1 Actors in the system, will be used to describe the actors in each use case diagram.

Table 1 Actor in the System

| **Actor Name** | **Description** |
| --- | --- |
| Air Quality Analysts | Air Quality Analysts use synthesized earth observations to improve the characterization of smoke events. Their analyses support decision making for air quality management, such as the analyses of exceptional events and long-range pollution transport. |
| Air Quality Compliance Manager | An Air Quality Compliance Manager ensures that States are complying with Air Quality regulations, and is responsible for assessing whether a regional pollution even was due to an "exceptional event". |
| Earth Observation Providers | Earth Observation Providers expected for Air Quality include:National, State/Provincial, Local Environmental Management AgenciesNational Meteorological AgenciesNational Space AgenciesNational Land Management AgenciesIndustryConsultantsAcademic and Other Research InstitutesInternational Cooperative for (e.g. WMO, CEOS, EEA, ...) Health SectorHealth authorities need to assess public health impacts of air pollution episodes and respond to extreme events. Health authorities must issue warnings when air pollution could harm the public.  |
| Modeler | The Modeler runs offline forecast models. This forecast data is made available through CALPUFF. |
| Policy Maker | States in the USA have requirements to comply with Air Quality regulations. However, in certain events such as fires they can apply to have a location waived from being considered for Air Quality compliance to regulations. |
| Public | The public is interested in air quality and pollution events that are currently happening, and that are forecasted in the near future, so that activity decisions can be made. |
| State | States in the USA have requirements to comply with Air Quality regulations. However, in certain events such as fires they can apply to have a location waived from being considered for Air Quality compliance to regulations.  |

##### 2.1.2.2.1 Use Case: “Assess Air Quality Compliance”

Purpose:

States are required to be in compliance with Air Quality regulations; therefore Air Quality Managers are responsible for assessing whether a regional pollution even was due to an "exceptional event" (such as fire, dust storm, etc). GEOSS AIP2 can facilitate linking between actors and by promoting the development and distribution of service-oriented, interoperable tools for inter-comparison and fusion of models, observations, and emissions data for use in Exceptional Event Analysis. In this example during scenario development state was defined but a state diagram was never developed. In the AIP-3 we will develop a state diagram for each scenario.

We will define pre and post conditions for each Use Case Diagram as defined in the Use Case Narrative

Evolution: Here we will define each step of the Use Case

Scenario builders did not always define pre and post conditions. We will work with them and define any post and pre conditions for all scenarios.

Pre-Conditions:

Not defined

Post-Conditions:

Not defined

Processes:

Processes are defined for each scenario and then used as roadmap of activity diagrams that need to be developed.

The following activity diagram “Request Exceptional Waiver Event” illustrates the process that is initiated by the state to request an Exceptional Waiver for an event, which could be a Wildfire.

The enterprise viewpoint describes the business requirements for the Air Quality management and decision support using GEOSS-2 without specifying the technology or other system considerations.

The Enterprise View defines use cases for Air Quality, using Object Management Group's Unified Modeling Language (UML). The sections that follow the Overview Use Case Diagram are organized by use case and describe the series of processes for each of the use cases. The processes are defined by activity diagrams, and are currently limited in scope to only the Wildfire scenario from AIP-2.

The following activity diagram “is an Activity diagram that uses the use cases as activities, this supports the Use Case Diagram horizontal view. Activity diagrams will also be built for each use case and these will represent the processes of the Use Case Diagram.

Figure Air Quality Overview Activity Diagram

State

Request Exceptional

Event Waiver

Exceptional Event Request

[Approved]

Decision Sent

DecisionWaiverRequest

Request Exceptional

Event Waiver

Exceptional Event Request

[Approved]

Decision Sent

DecisionWaiverRequest

DecisionWaiverRequest

Air Quality Compliance Manager

Determine if waiver

should be approved

SelectedSmokeObsData

SelectedSmokeForecastProducts

DecisionWaiverRequest

Select 1 or more Smoke

Forecast Products

returned by query

SelectedSmokeForecastProducts

ForecastProdQResults

Query Satellite

Smoke

Observations

Data Sets

SatSmokeObsQuery

Query Smoke

Forecast

Products

ForecastProdQuery

Exceptional Event Request

[Created]

Retrieve Satellite Smoke

Observations Data Sets

SatSmokeObsQueryResults

SatSmokeObsQuery

Query Surface

Smoke Obs

Data

SurfSmokeObsDataQuery

Select 1 or more dta

sets returned by Smoke

Obs query

SelectedSmokeObsData

SatSmokeObsQueryResults

SurSmokeObsDataQResults

Exceptional Event Request

[Rejected]

Determine if waiver

should be approved

SelectedSmokeObsData

SelectedSmokeForecastProducts

DecisionWaiverRequest

SelectedSmokeObsData

SelectedSmokeForecastProducts

DecisionWaiverRequest

Select 1 or more Smoke

Forecast Products

returned by query

SelectedSmokeForecastProducts

ForecastProdQResults

SelectedSmokeForecastProducts

ForecastProdQResults

Query Satellite

Smoke

Observations

Data Sets

SatSmokeObsQuery

SatSmokeObsQuery

Query Smoke

Forecast

Products

ForecastProdQuery

ForecastProdQuery

Exceptional Event Request

[Created]

Retrieve Satellite Smoke

Observations Data Sets

SatSmokeObsQueryResults

SatSmokeObsQuery

SatSmokeObsQueryResults

SatSmokeObsQuery

Query Surface

Smoke Obs

Data

SurfSmokeObsDataQuery

SurfSmokeObsDataQuery

Select 1 or more data

sets returned by Smoke

Obs query

SelectedSmokeObsData

SatSmokeObsQueryResults

SurSmokeObsDataQResults

SelectedSmokeObsData

SatSmokeObsQueryResults

SurSmokeObsDataQResults

Exceptional Event Request

[Rejected]

WCS

Retrieve Surface Smoke

Obs Data

SurfSmokeObsDataQuery

SurSmokeObsDataQResults

Perform Query Smoke

Forecast Products

ForecastProdQuery

ForecastProdQResults

«block»

Retrieve Surface Smoke

Obs Data

SurfSmokeObsDataQuery

SurSmokeObsDataQResults

SurfSmokeObsDataQuery

SurSmokeObsDataQResults

Perform Query Smoke

Forecast Products

ForecastProdQuery

ForecastProdQResults

ForecastProdQuery

ForecastProdQResults

[Approved]

[Rejected]

#### 2.1.2.3 Engineering Design

We will develop the engineering design by developing the remaining four views defined in ISO/IEEE 19793. These are Information View, Computational View, Technical view and Engineering view. We will build these views by collaborating with SBA Community experts and other AIP system engineers and produce optimized designs for the Enterprise View Models by refining the Use Cases, information objects, and selecting technology and component types.

##### 2.1.2.3.1 Information View

The information specification viewpoint is concerned with information modeling. We have simplified the number of diagrams by offering all parts of view in an Entity Relation Diagram or using a UML Class Diagram. It contains each information object its attributes and relationships with other information objects. See Figure 3 below for an example taken from the Pika scenario of AIP-2.



Figure 3 Pika Information View

##### 2.1.2.3.2 Computational View

The computational view will be described in accordance with ISO/IEC 19793 for the use of UML/SySML for Open Distributed Processing system specification.

The computational specification functionally decomposes air quality management and decision support using the GEOSS-2, with “units of function as computational objects, and interactions among those computational objects, without considering their distribution over networks and nodes.”

###### Basic structure of the computational viewpoint for Air Quality

The following diagram describes the elements or packages of the computational viewpoint used for Air Quality in AIP-2 that we will use in AIP-3 as our model. Interface templates are described as ports, where interface signatures define operations that can handle data and return values. Computational objects are components and are also described by their templates.



Figure 4 Basic structure of the computational viewpoint for Air Quality

###### Object and Interface Templates

High-Level Architecture

In the following component diagram, system functionality is decomposed into computational objects (or components) that interact at the interfaces (or port instances). The system consists of four main components – the Air Quality Main Functionality for Wildfire, and the user interfaces that interact with it which includes the Modeler, the Air Quality Analyst/Manager, and the GEOSS Registry. This defines the high-level architecture.



Figure 5 Computational object templates and interface signatures

###### Detailed Architecture

The following component diagram decomposes the high-level architecture further to define the internal components, and interactions between those components

**ibd**

[block] AQ Wildfire

«part»

: AQSystemMain FunctionalityWildfire

 : QuerySmokeData

 : SmokeReportQuery

 : SrchAQSvcs\_Alerts

«part»

: USFS SMARTFIRESOAPSVC

 : QuerySmokeFcst

«part»

:

Feature-

Svc

«part»

:

CoverageSvc

«part»

: Crawler

 : AQCommCat

«part»

: FSD

«part»

:

WEBAgent

«part»

: WSD

 : Smoke Fcst Products/Data

 : WMSSvc

 : SmokeReportResponse

 : WCSSvc

«part»

: AQ Community Catalog

 : SrchAQSvcs\_Alerts

«part»

: WAF

«part»

:

Application-

Provider

«part»

:

INSPIREMeta-

data

 : AQComCat

«part»

: WMS

«part»

:

CESIIN

«part»

: WSD

 : WCSInfo

«part»

:

WEBAgent

«part»

: FSD

 : WMSSvc

«part»

: WCS

 : WCSSvc

«part»

: CALPUFF

«part»

: OMI AerAbs

«part»

: AIRNow

«part»

: WSD

 : WCSInfo

«part»

: FSD

«part»

: WEBAgent

 : SmokeFcstRpt

«part»

BlockProperty1 : <part>

: Registry

 : GEOSS

:

Clearinghouse

 : AQCOMMCat

 : QuerySmokeData

 : SmokeReportQuery

 : SrchAQSvcs\_Alerts

«part»

: USFS SMARTFIRESOAPSVC

 : QuerySmokeFcst

«part»

:

Feature-

Svc

«part»

:

CoverageSvc

«part»

: Crawler

 : AQCommCat

«part»

: FSD

«part»

:

WEBAgent

«part»

: WSD

 : Smoke Fcst Products/Data

 : WMSSvc

 : SmokeReportResponse

 : WCSSvc

 : QuerySmokeFcst

«part»

:

Feature-

Svc

«part»

:

CoverageSvc

«part»

: Crawler

 : AQCommCat

 : AQCommCat

«part»

: FSD

«part»

:

WEBAgent

«part»

: WSD

 : Smoke Fcst Products/Data

 : Smoke Fcst Products/Data

 : WMSSvc

 : SmokeReportResponse

 : WCSSvc

«part»

: AQ Community Catalog

 : SrchAQSvcs\_Alerts

«part»

: WAF

«part»

:

Application-

Provider

«part»

:

INSPIREMeta-

data

 : AQComCat

 : SrchAQSvcs\_Alerts

«part»

: WAF

«part»

:

Application-

Provider

«part»

:

INSPIREMeta-

data

 : AQComCat

«part»

: WMS

«part»

:

CESIIN

«part»

: WSD

 : WCSInfo

«part»

:

WEBAgent

«part»

: FSD

 : WMSSvc

«part»

:

CESIIN

«part»

: WSD

 : WCSInfo

 : WCSInfo

«part»

:

WEBAgent

«part»

: FSD

 : WMSSvc

«part»

: WCS

 : WCSSvc

«part»

: CALPUFF

«part»

: OMI AerAbs

«part»

: AIRNow

«part»

: WSD

 : WCSInfo

«part»

: FSD

«part»

: WEBAgent

 : WCSSvc

«part»

: CALPUFF

«part»

: OMI AerAbs

«part»

: AIRNow

«part»

: WSD

 : WCSInfo

 : WCSInfo

«part»

: FSD

«part»

: WEBAgent

 : SmokeFcstRpt

«part»

BlockProperty1 : <part>

: Registry

 : GEOSS

:

Clearinghouse

 : AQCOMMCat

: Registry

 : GEOSS

:

Clearinghouse

 : AQCOMMCat

«part»

: Modeler

 : WCS Service

 : WCS Service

«part»

: GEOSSRegistry

 : SrchAQSvcs\_Alerts

 : SrchAQSvcs\_Alerts

: Manager/Analyst

 : SmokeFcst

 : SmokeFcst

**ISmokeDataQuery**

**IRegResource**

**ISmokeReportResponse**

**IWMSQ**

**IWCSQ**

**ISmokeFcst**

**IAQCommCat**

**ISmokeDataQuery**

**ISmokeDataQuery**

**ISmokeReportResponse**

**ISmokeReportResponse**

**ISmokeFcst**

**ISmokeFcst**

**IRegResource**

**IRegResource**

 : FeatureReq

 : FeatureRES

 : FeatureReq

 : FeatureRES

 : CovReq

 : CovRes

 : CovReq

 : CovRes

 : GetData

 : DataResp

 : GetData

 : DataResp

 : WMSResp

 : WMSQ

 : WMSResp

 : WMSQ

 : PopDensityQ

 : PopDensRpt

 : PopDensityQ

 : PopDensRpt

 : Coverage

 : Coverage

 : MapCov

 : Fcsts

 : MapCov

 : Fcsts

 : DescripQ

 : Descrip

 : DescripQ

 : Descrip

 : Coverage

 : Coverage

 : QPopDensity

 : QPopDensity

 : REGAQRes

 : REGAQRes

 : SrchCommCat

 : SrchCommCat

Figure 6 Detailed Architecture using SysML Internal Block Diagram

##### 2.1.2.3.3 Engineering View

The engineering viewpoint is concerned with the mechanisms and functions required to support distributed interaction between objects in the system. An engineering specification defines the structure of node (nucleus, capsule, cluster, and (basic) engineering objects), channel, and their management functions. We will use a UML Component Diagram as displayed using the SySML extension Internal Block Diagram.

Component-based development (CBD) and object-oriented development go hand-in-hand, and it is generally recognized that object technology is the preferred foundation from which to build components.  I typically use [UML 2](http://www.agilemodeling.com/essays/umlDiagrams.htm) component diagrams as an architecture-level artifact, either to model the business software architecture, the technical software architecture, or more often than not both of these architectural aspects.



Figure 7 UML 2 Component Diagram

##### 2.1.2.3.4 Technology View

. The technology viewpoint is concerned with the choice of technology to implement the ODP system. A technology specification defines technology objects (hardware, software, and network products), which implement implementable standards as its templates, implementation as a process of instantiation, and IXIT as implementation extra information for testing.

The primary diagram for this specification is a UML Deployment Diagram.

[UML 2](http://www.agilemodeling.com/essays/umlDiagrams.htm) deployment diagram depicts a static view of the run-time configuration of processing nodes and the components that run on those nodes. In other words, deployment diagrams show the hardware for your system, the software that is installed on that hardware, and the middleware used to connect the disparate machines to one another.



Figure 8 UML 2 Deployment Diagram

#### 2.1.3Plans for interacting with the Standards (SIF), GEOSS Standards Registry, and Interoperability Forum.

On line access will be gained via <http://seabass.ieee.org/groups/geoss> link. Interoperability in GEOSS will be achieved primarily by specifying how GEOSS components exchange data and information at their interfaces. The GEOSS strategy is to realize a system of systems through adoption of selected international standards that enable interoperability.  The mechanism that facilitates the interoperability is the GEOSS architecture, which is realized by the components implemented as part of the GEOSS Common Infrastructure (GCI).  The INCOSE team will be modeling how GEOSS components will change data and information at their interfaces during the construction of the Computational, Engineering and Technology views. These diagrams will be exchanged to GEOSS AIP-3 team members via the SIF and standards we invoke place in the Standards and interoperability registry.

#### 2.1.4 Plans for use of the GEOSS Best practices Wiki (BPW).

We will use the products we develop during AIP-3 in the GOSS Architecture in the form of comments, contributions, development and convergence to best practices realized during the completion of the architecture process. Access to the BPW will be via the <http://wiki.ieee-earth.org> link. We will also be assisting with software builds based on the architecture we produce and its ultimate unit testing, integration testing and system testing.

#### 2.1.5 Description of INCOSE in standards developing organizations and relevant experience in open standards.

INOSE is involved in participating in the development and maintenance of several standards including the ISO/IEC 10746 and 19793. The proposed INCOSE Architecture team has three years of experience developing UML/SySML Architecture for GEOSS during AIP-1 and 2. Several team members have been using these standards to produce Open Distributed Systems, Systems of Systems and Family of Systems on both commercial, Department, Defense, and other Government Agencies.

#### 2.1.6 Plans to support refinement and elaboration of the currently defined architecture and interoperability arrangement during Pilot activities.

Darning AIP 3 we will improve upon the Architecture built during that effort by adding policies, sequence diagrams, state diagrams and technical and engineering views. We will also work with SBA teams to make modifications to the existing architecture diagrams to reflect changes in the scenarios.

## Description of the Responding Organization

Described below is the INCOSE description of how the INCOSE organization will relate to the GEO Lead for the AIP-3 effort, Societal Benefit Areas, Components and Service Contributors.

## Organization and description

The INCOSE effort to support GEOSS AIP-3 will be under the direction of the Technical Operations structure of INCOSE. In particular it will be directly under the Government Assistant Director Carl Landrum. Under the Assistant Director of Government will be the GEOSS Working Group Chair Lawrence McGovern, DsC. He will also be the programmatic and technical director of AIP-3 INCOSE Architectural effort. The Programmatic POC will interface with the GEO AIP lead and the Technical POC will interface with SBA Chairs and other Working Group Chairs.

|  |
| --- |
| The actual Technical Operations structure consists of all INCOSE [Working Groups](http://www.incose.org/practice/techops/index.aspx), supported by six Assistant Directors plus an Internal Operations Group. There is a direct linkage between each Working Group and a specific Assistant Director.The Assistant Directo and the related Working Groups (WG) and WG Chairs to contact ar:*

Government - Carl Landrum * Global Earth Observation System of Systems (GEOSS) - Larry McGovern

Technical Operations also includes an Associate Director of Internal Operations. Internal Operations is the element that focuses on technical events, technical communications, planning, procedures and publications. Specifically: * Technical Communication - Tim Dilks
* Technical Events - Terje Fossnes
* Technical Information - Richard Freeman
* Technical Planning - Joe Elm
* Technical Review - Yoshiaki Ohkami, Assistant Director

Technical Operations is led by INCOSE's Technical Director and Deputy Technical Director |
|   |
|   |

## 3.2 Identification of human and System Resources to be assigned

### 3.2.1 System Resources

System resources required include access to Artisan 7.1 that will accommodate five users at same time and a dedicated server that is accessible through CITRIX. Artisan Corporation provided this service during AIP-2 and has graciously consented to continuing this service through the period of performance of AIP-3 effort. Each team member will provide their own personal computer to access web and Artisan 7.1.

### 3.2.2 Human Resources

Human resources summarized in Table 2 Identification of Human resources to be assigned to the AIP-3 Phase and planned level of participation in hours. A total of five system engineers that have had experience in using the UML and SySML syntaxes and have experience in developing ODP architectures will be part of the INCOSE AIP-3 team. Three of the five team members are returning members of the INCOSE team and worked on all views developed in AIP-2. The new members will be selected from experienced ODP developers that have used UML and SySML syntax. All team members will receive training in the ISO/IEC 10746:1996 Part 3 Reference model and ISO/IEC 19793:2007 standards or a refresher prior to start of development.

|  |  |  |
| --- | --- | --- |
| Labor Category | AIP-3 Architecture and interoperability task | Estimated Labor Hours |
| Chief Architect | All | 450 |
| Enterprise Architect | Enterprise View Development | 500 |
| Information Architect | Information view development | 500 |
| Computational Architect | Computation View development | 500 |
| Engineering Architect | Engineering view Development | 600 |
| Technical Architect | Technical view development | 600 |
| Totals |  | 3150 |

Table 2 Identification of Human Resources

## 3.2 Contact Information

### 3.2.1 Programmatic and Technical Contact information

Programmatic and Technical Point of Contact information is the same.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Programmatic and technical Contact Information | Email | Work phone | Cell phone | Home Phone |
|  | Lawrence.mcgovern@tasc.com | 703-227-3138 | 301-890-5982 | 3018907066 |

Table 3 Programmatic and Technical POC Information