COMPONENT 2:

CONCEPT OF OPERATIONS EXERCISE

INSTRUCTOR VERSION

February 25, 2017

The following is an exercise that will allow you to begin developing a Concept of Operations or ConOps based on a given transportation opportunity. Although the development of some of the key parts of the ConOps is important, a basic understanding of the beginning of the systems engineering process and systems thinking are the primary "take aways" from this exercise.

The focus of this exercise revolves around the potential deployment of ITS for a major university event trip generator – a Saturday afternoon football game. Instructions about each of your tasks follow the description below. You will develop a document recording your findings and answering the questions within the tasks.

YOUR ROLE

You are a new traffic engineer at the City's Department of Transportation (City DOT). Your job responsibilities to this point have included traffic studies, data collection, traffic signal timing, and numerous other tasks. Your supervisor has been a City DOT engineer for 20 years and did all the same type of work you are doing now. However, with recent technological advancements in the traffic and transportation field, some new approaches to how the City manages its transportation system have been introduced. While your supervisor understands the benefits of this approach, there is apprehension about how it all works. Previous transportation projects involving ITS have not been able to meet schedule and budget. After consultation with other agencies regarding their ITS deployment challenges and successes, your supervisor has decided that performing a systems engineering analysis may help to better ensure project success.

DESCRIPTION

A football game represents the biggest event that your City has to accommodate. There are typically six to seven home games a year, each drawing close to 80,000 people into the City on game days. The university campus is located in the middle of your City. However, its football stadium is located off-campus, about two miles from the heart of campus.

In the past 15 years, traffic conditions on home game weekends have degraded each year. As the team has improved under new leadership, attendance has grown which has steadily increased car traffic and the tail-gating activities prior to and after game time. In turn, this has increased the congestion and spread it over a longer period of time.

To capitalize on this new found vigor for the football program, the University made a commitment to expand the stadium to accommodate an additional 15,000 seats. Thus, the record draw of alumni and fans to the games is only expected to increase as the stadium is expanded for more seats.

Once it was decided to expand the stadium, the University commissioned a study to assess the current and future demand being fueled by the record attendance. The study concluded that traffic conditions will not improve unless new roadway access and traffic management features are put in place. The roadway expansion is severely limited due to the unavailability of land for new roads around the stadium; therefore, using traffic technology is imperative. The City Transit Authority currently services

both the city and the university from a transit management center. The study also recommended that the city transit capabilities be expanded to include tracking transit vehicles and adding special event routes on game days. Improved parking management was identified to better utilize the city and university parking lots. Both the city and university police departments are critical to ensure safety and smooth traffic operations on game days.

Since the stadium sits off-campus and is surrounded by City-maintained streets and traffic signals, the University approached the City DOT engineer (and you) with their stadium expansion plans and completed traffic impact study. The study recommended a plan be developed to handle traffic before, during, and after the game on the campus grounds, the stadium grounds, the freeways, arterials, and local streets that surround the stadium used for ingress and egress. The study made it clear that an overhaul of the existing City's Traffic Management Center (TMC) would be needed in order to enhance center-to-center communications as well as additional ITS devices such as dynamic message signs, vehicle detectors, parking occupancy detectors and cameras.

Your first task is to figure out how to begin using systems engineering. Recalling some recent system engineering training, you remember that you need to determine the justification and scope of your project.

Task 1: Identify Stakeholders along with their Roles and Responsibilities

One of the most difficult parts of the systems engineering process is getting started. Typically you do not just brainstorm a project and there is funding just waiting for you. More likely, you will be given some information from transportation plans whether they are long range, transportation improvement, congestion mitigation or something else. In this exercise the main driver for upgrading or enhancing the ITS services is the current situation surrounding traffic management around the stadium exacerbated by the stadium expansion.

As a transportation engineer it is your job to develop the rationale for procuring systems to satisfy the needs of the stakeholders. So a great place to start is analyzing who exactly are your stakeholders? The brief description of the project situation gives some insight as to who are the stakeholders and provides some hints about stakeholders who might not be so obvious. Stakeholders can be agencies, operators, the public and anyone else who is affected by the project scope.

Read through the brief description and write down your best guess regarding the stakeholders for this project.

List of Stakeholders
City Department of Transportation/TMC Operators
City Police Department

List of Stakeholders
State Department of Transportation
City Transit Department/Authority
City Parking Department/City Parking Operators
University Department of Transportation
University Parking Department
University Police Department
Travelers

It is important to capture the high-level roles and responsibilities for each stakeholder they pertain to their place in overall transportation operations for the project description. Capturing this information helps everyone understand each stakeholder's point of view and responsibilities. This exercise will not delve deeply into this topic but it is good for you to think about it!

A few questions:

1. Who is the stakeholder that is most central to the project?

   This may be obvious but it is important to identify the stakeholder that is central to the project, in this case the City DOT. Most successful projects have a champion stakeholder who has the overall responsibility for the project and a key role or primary system ownership.

2. Why could the State DOT be involved?

   The State DOT usually is responsible for the freeways; since this project could impact the freeways and could provide additional field equipment in the vicinity of the freeway it is important to involve the State DOT.

3. Is it a good idea to include transit stakeholders? Why or why not?

Although it appears that this project is not primarily a transit project, the addition of field devices and an improved Traffic Management Center will benefit the City transit operations. Potentially sharing traffic conditions and camera images would enhance the overall traffic management around the stadium including transit. Transit is also a service whose benefits are related to addressing the problem involved in this exercise.

At this point in developing your ConOps it is better to over specify primary and secondary stakeholders, after further analysis as you develop your ConOps you may decide to de-emphasize one or more stakeholders.

Task 2: Determine the Current Situation

Your next task in developing a ConOps is to briefly describe the current situation. This is important for two main reasons (1) it provides a common understanding of the environment that the project will be dealing with, and (2) it defines the scope of the project. The description of the project given at the beginning of this exercise is a good example of a description of the current situation. This description is normally derived from communicating with the stakeholders potentially affected by the project.

The scope of the project can be determined from a regional ITS architecture, if you have one. A regional ITS architecture models the ITS elements/systems and their connections with one another. A project ITS architecture is just a smaller subset of the region, specifically for a project.

Your next task is to relate your stakeholders listed in Task 1 to their current or existing transportation systems. Their systems could be classified as a center, traveler device, vehicle or a field device. For example the first row is filled in to show that the State DOT operates a Freeway Traffic Management Center, Cameras, Dynamic Message Signs and Vehicle Detectors that are applicable to this project. Copy your stakeholders from Task 1 in column 1 and add the transportation systems mentioned or hinted at in the project description.

List of Stakeholders	Transportation Systems
City Department of Transportation/TMC Operators	**City Traffic Management Center** **City Cameras** **City Dynamic Message Signs** **City Vehicle Detectors**

List of Stakeholders	Transportation Systems
State Department of Transportation/TMC Operators	Freeway Traffic Management Center Freeway Cameras Freeway Dynamic Message Signs Freeway Vehicle Detectors
City Transit Department/Authority/Transit Management Center Operators	City Transit Management Center City Transit Vehicles
City Parking Department/City Parking Operators	City Parking Occupancy Detectors
City Police Department	City 911 Call Center City Police Vehicles
University Department of Transportation	University Traffic Management Center University Cameras University Dynamic Message Signs University Vehicle Detectors
University Parking Department	University Parking Occupancy Detectors
University Police Department	University Police Vehicles
Travelers	Smart Phones/Devices

Task 3: Justification for Change

If the current situation is acceptable, there is no reason to make any changes; this is frequently referred to as the "Do Nothing" alternative. However, usually there is a combination of factors that necessitate a change to transportation operations. In this case, the expansion of the stadium capacity coupled with the improvement of the football team is causing an increase in traffic conditions. This increase in traffic conditions is affecting the stakeholder's needs. One of the most important parts of a ConOps is to capture these user (stakeholder) needs. User needs as well as the ConOps document must be written in the stakeholder's language so it is easy for the users of the proposed system to understand.

Recall the Criteria for Writing a "Well-Written" User Need:

When documenting a user need, one must remember that it addresses an operational problem, and "*describe*" it using the following recommended criteria:

1. Provide a structure by assigning a unique number and title to make it **uniquely identifiable**
2. Identify a **major desired capability** (Including functions or features you desire from the device/system)
3. Capture the **rationale** by stating why it is needed by the user.
4. Keep it **solution-free**: don't get into how to meet it (design).

An example of a user need for configuring Transit Automatic Vehicle Location (AVL) which could be part our set of user needs for this ITS project was given as:

UN 3.10 Configure Transit Vehicle Tracking System

The Transit Operator needs to enter the bus route information into the transit vehicle in order for the transit vehicle to track its status against the route schedule and provide bus stop announcements.

Note: this user need does not specify how this will be accomplished, it only specifies the need. Also, it is important to capture the need of the user not the system. System requirements will be developed after the user needs are defined in a Systems Requirements Document.

Another example is given below for monitoring traffic conditions, ask yourself who needs to do this and why.

UN 3.4 Monitor Traffic Conditions

The Traffic Management Center Operator needs to monitor and verify the traffic conditions around the stadium for both the freeway and arterial roadways in order to better manage the traffic around the stadium.

The following user needs titles are given; it is your job to write a corresponding user need description that meets the criteria listed above. Note that this is only a partial list of user needs.

UN 3.7 Provide Traffic Condition Information to Travelers

Travelers need traffic conditions in the vicinity of the stadium in order to allow travelers to make informed decisions.

UN 3.12 Monitor Transit Vehicles

The Transit Management Center Operator needs to monitor its Transit Vehicles in order to better manage the transit network and provide transit vehicle information to travelers.

UN 3.19 Exchange Traffic Condition Information between the Traffic Management and Transit Management Centers

The Traffic Management Center Operators and Transit Management Center Operators need to share their traffic condition information with each other in order to provide better traffic coordination around the stadium.

It is important to avoid getting too detailed with the user needs definition and unnecessarily constrain design choices. For example, what is wrong with the following user need?

UN 3.4.1 Retrieve Remote Traffic Conditions using Cameras

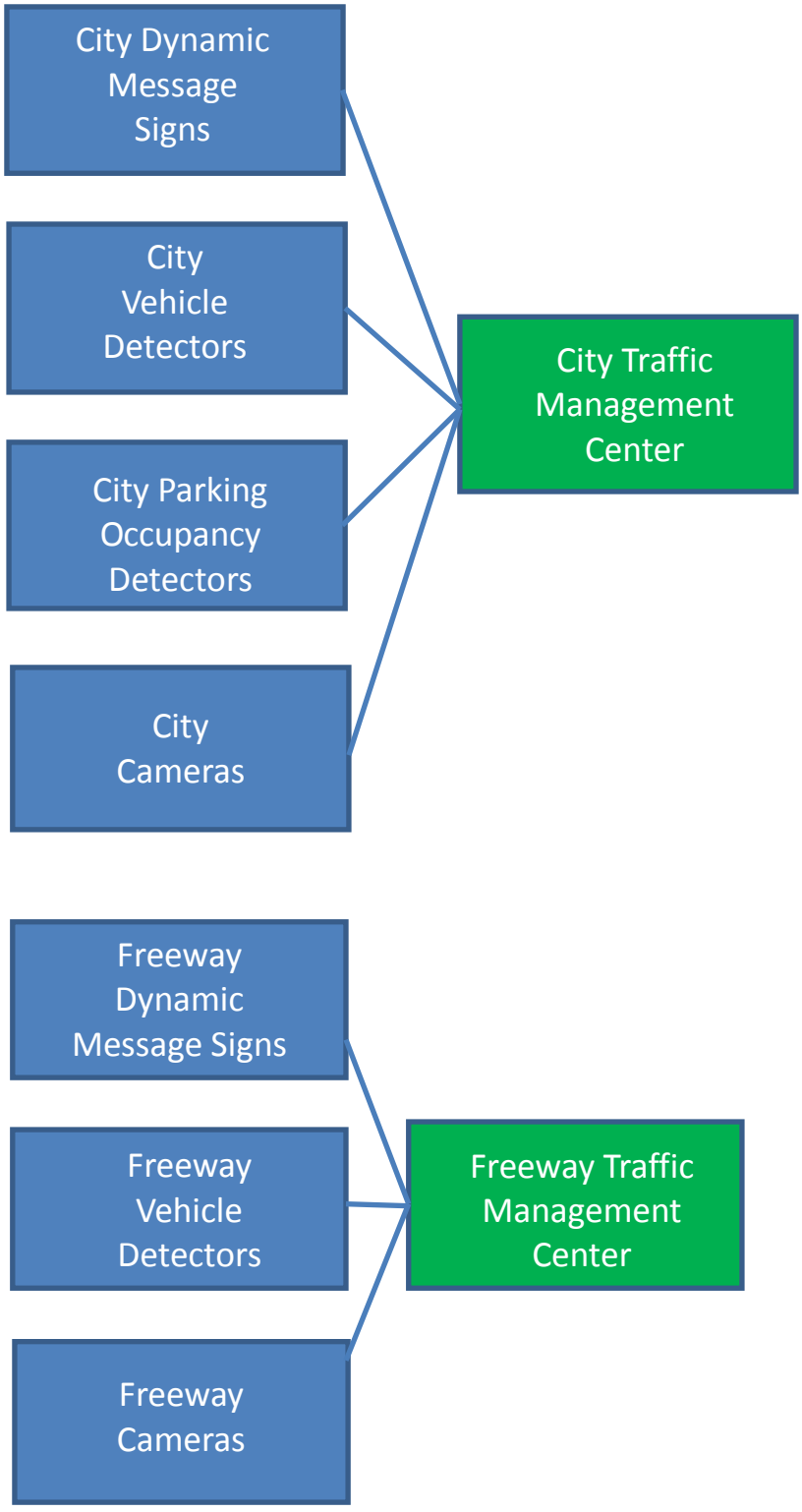
The City TMC Operator needs to remotely retrieve freeway and arterial roadway traffic conditions by controlling cameras in order to obtain current roadway operational conditions.

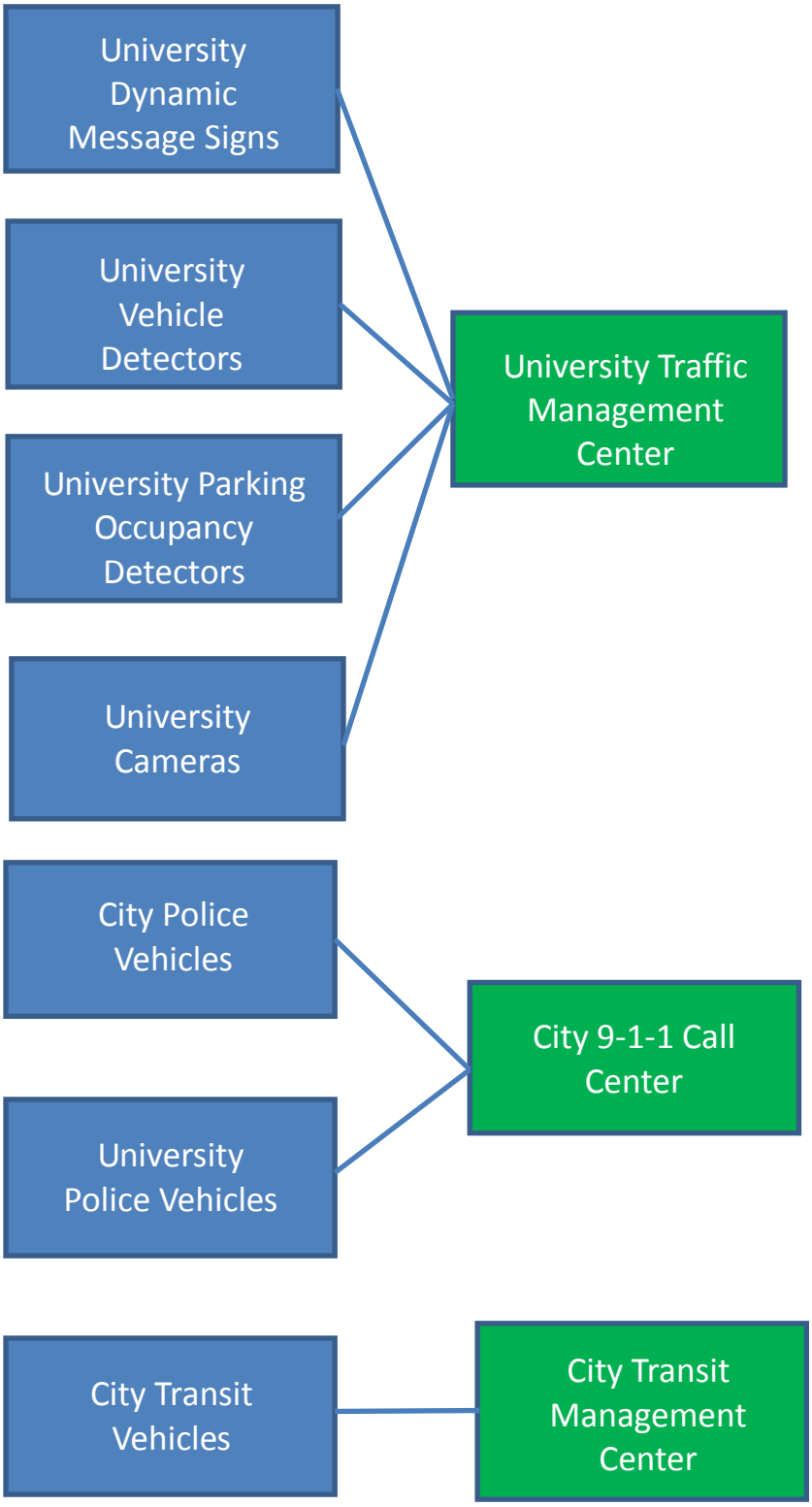
This user need assumes that cameras will be used to retrieve remote traffic conditions. Cameras may end up being used but the user need is to obtain remote traffic conditions, it may be better to use some roadway sensors/traffic detection or a combination of sensors and cameras.

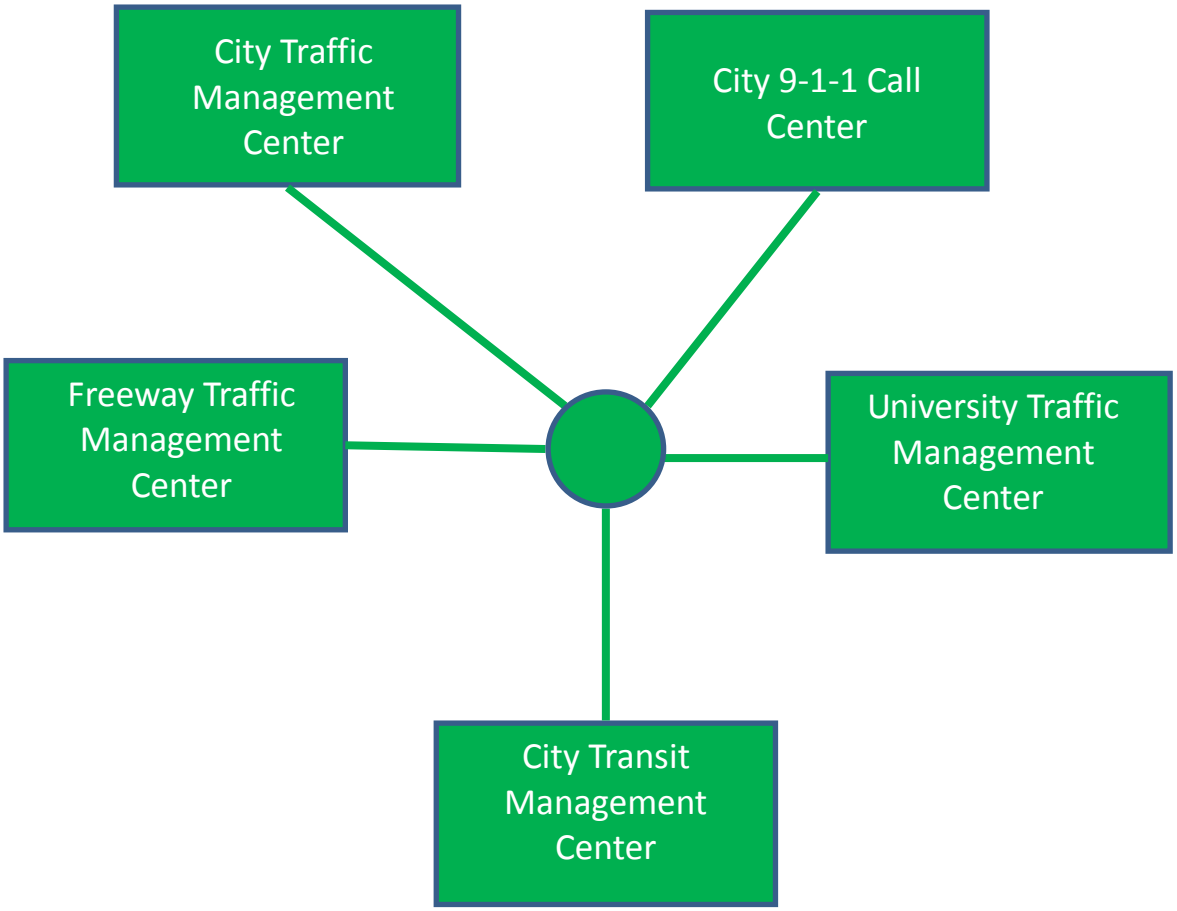
Task 4: Concepts for the Proposed System

Another section of most ConOps documents is a description of the concept for the proposed system. This description takes into account the agency policies and constraints impacting the system such as rules regarding placement of devices, sharing of information between agencies, etc.

A high-level block diagram of the proposed system components helps to define the scope of the project. Based on your understanding of the proposed project, sketch a rough block diagram of the major systems and the information they communicate with each other. Make sure you label your system blocks as well connect the blocks where there is information communicated between them.


City Dynamic Message Signs
City Vehicle Detectors
City Parking Occupancy Detectors
City Cameras
City Traffic Management Center
Freeway Dynamic Message Signs
Freeway Vehicle Detectors
Freeway Cameras
Freeway Traffic Management Center


University Dynamic Message Signs
University Vehicle Detectors
University Parking Occupancy Detectors
University Cameras
University Traffic Management Center
City Police Vehicles
University Police Vehicles
City 9-1-1 Call Center
City Transit Vehicles
City Transit Management Center


City Traffic Management Center
City 9-1-1 Call Center
Freeway Traffic Management Center
University Traffic Management Center
City Transit Management Center

Example Block Diagram

The above block diagrams contain blocks for each ITS element or system. The blocks are connected together where information is exchanged. There are really two types of interfaces, center-to-field/vehicle and center-to-center. The center-to-field/vehicle interfaces show up around the five centers:

City Traffic Management Center
- City Cameras
- City Parking Occupancy Detectors
- City Dynamic Message Signs
- City Vehicle Detectors

City Transit Management Center
- City Transit Vehicles

City 911 Call Center
- City Police Vehicles
- University Police Vehicles

University Traffic Management Center
- University Cameras
- University Parking Occupancy Detectors
- University Dynamic Message Signs
- University Vehicle Detectors

Freeway Traffic Management Center
- Freeway Cameras
- Freeway Dynamic Message Signs
- Freeway Vehicle Detectors

The center-to-center interfaces are between each center listed above.

Suggest class discussion on which elements currently exist and which elements are going to have new devices and connections. Also, stress to the class that the reason we are building an ITS system is to help the users, the resulting block diagram(s) should trace back to the user needs.