ASSESSING NEEDS AND IDENTIFYING OPPORTUNITIES FOR ITS APPLICATIONS IN CALIFORNIA'S NATIONAL PARKS

Technical Memorandum 5: Integrating National Parks into a Regional ITS Architecture

by

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EXECUTIVE SUMMARY

National parks protect numerous irreplaceable historic, cultural, archeological and natural features. They also provide educational and recreation opportunities for millions of visitors every year. Increasing demand for visiting national parks in recent years has increased congestion in parks, limiting access and mobility, and hindering the visitor experience. Some of the most affected parks have been looking for solutions to address these challenges. Since expansion of infrastructure – i.e. additional roads, larger parking lots – is typically impractical, parks are investigating other alternatives, such as intelligent transportation systems (ITS), which use technology to make the transportation system work better.

As national parks get more interested in ITS solutions, it becomes critical that these solutions are effectively integrated with other ITS solutions in the same region, state, and even across the country. Effective integration of ITS for a national park will mean going beyond the boundaries of the park. To promote integration, it is necessary to use the National ITS Architecture, a nationally-developed framework for modeling the sharing of information between agencies and organizations to support an ITS project. However, few national parks have experience with the National ITS Architecture, and national parks are often not considered as significant stakeholders in regional ITS planning efforts.

Therefore, the purpose of this document is to help national parks find their place in a region's ITS architecture. The document will do this by focusing on Golden Gate National Recreation Area (GGNRA), a park that was examined as a case study for ITS applications in a project funded by the California Department of Transportation (Caltrans) Division of Research and Innovation.

This document presents a regional architecture covering GGNRA, which is located on two peninsulas between the Pacific Ocean and San Francisco Bay, connected by the Golden Gate Bridge. This architecture covers existing and potential ITS deployment over a 10-year horizon. The stakeholders who were involved in identifying existing ITS devices, assessing needs for the park and visitors, and recommending ITS devices to deploy include counties, concessionaires, community-based organizations, emergency services, federal agencies, gateway communities, park partners, state agencies, regional agencies, and transit agencies.

The inventory of existing/planned ITS infrastructure for GGNRA is shown in Table ES-1.

Stakeholder	Element	Status	Architecture Entity
Caltrans / NPS- GGNRA	Closed Circuit Television (CCTV) to show park sites	Planned	Roadway Subsystem (subsystem)
NPS-Golden Gate National Recreation Area	Two Portable Changeable Message Signs (CMS)	Existing	Roadway Subsystem (subsystem)
	Traffic Counters	Existing	Roadway Subsystem (subsystem)
	Parking Occupancy Counters	Planned	Roadway Subsystem (subsystem)
	Kiosks	Planned	Remote Traveler Support
Marin County Office of Emergency Services (MC-OES)	Highway Advisory Radio (HAR) near Mountain Home	Existing & Planned	Roadway Subsystem (subsystem)
Metropolitan Transportation Commission	Inclusion of GGNRA information on 511	Planned	Information Service Provider (subsystem)

 Table ES-1: Existing and Planned ITS Infrastructure in GGNRA

The challenges for GGNRA were identified by data pertaining to visitation, average daily traffic, vehicle classification, parking, and accident history, along with conducting outreach to identify needs for visitors, park staff, and other affected stakeholders. The challenges identified included:

- roadway congestion
- inadequate access
- limited parking
- transit coordination and information
- lack of planning data
- traveler information
- work zone/event coordination
- emergency response

The following ITS themes were identified in Phase 1 of the ITS Applications in California National Parks project based on the above needs:

- roadway congestion forecasting
- data collection and storage
- parking management and information
- pre-trip traveler information
- transit trip planner
- major emergency response

The themes represented a long-term vision about how the park may pursue ITS. Based on continued outreach to the park and other stakeholders, several candidate early-winner projects were identified as relatively low-cost ways of moving toward the long-term ITS vision for the park. These candidate projects included:

- shared-use changeable message sign (CMS) at US 101/SR 1
- park-wide radio system
- Muir Woods/Stinson Beach cameras
- NextBusTM/AVL for MUNI and GGT
- parking reservation system
- park information database
- event management
- pedestrian/bike trail plan

Because of their affordability and potential responsiveness to park needs, these candidate earlywinner projects are considered medium-term. However, in some cases there was no consensus among all stakeholders that a candidate project will be implemented.

Marin parklands transportation planning efforts, formed in a partnership with many of the same stakeholders, made recommendations for ITS projects in the area that may have a better chance of short-term implementation. These projects include the following:

- highway advisory radio
- 511
- flip signs
- changeable message signs
- video cameras
- traffic counters
- parking occupancy counters
- kiosks

The implementation plan for this architecture states that the project phasing will be projects identified through the Comprehensive Transportation Management Plan (CTMP)¹ process, then the early-winner projects, and finally the ITS themes. The agency agreements used for this architecture are memorandums of understanding. It is assumed that this architecture will be integrated with the San Francisco Bay Area Regional Architecture and therefore will not be maintained as a separate document.

The architecture includes recommendations for future research, such as case studies of integrating national parks into regional ITS infrastructure, incorporating national park visitor

¹ CTMP as originally designed was formally terminated by the Marin County Board of Supervisors in March 2005. However, GGNRA is continuing to work with Caltrans District 4, Marin County and other local stakeholders to implement projects and concepts outlined in the CTMP effort.

information onto 511 traveler information systems, and identifying national park extensions to the National ITS Architecture.

1. INTRODUCTION

Transportation challenges at many national parks, including many in California, are creating the need to look at innovative solutions. Intelligent transportation systems (ITS) may be one way of addressing these transportation challenges without adding roadway infrastructure.

As national parks get more interested in ITS solutions, it becomes critical that these solutions are effectively integrated with other ITS solutions in the same region, state, and even across the country. Integration can offer many benefits, including making it easier for visitors to get real-time information as they are headed to a national park, allowing management to manage congestion proactively, and facilitating systemwide operational data collection.

Effective integration will mean going beyond the boundaries of the park. To promote integration, it is necessary to use the National ITS Architecture, a nationally-developed framework for modeling information-sharing between agencies and organizations to support an ITS project. However, few national parks have experience with the National ITS Architecture, and national parks are often not considered as significant stakeholders in regional ITS planning efforts.

Therefore, the purpose of this document is to help national parks find their place in a region's ITS architecture. The document will do so by focusing on Golden Gate National Recreation Area (GGNRA), a park that was examined as a case study for ITS applications in a two-phase project funded by the California Department of Transportation (Caltrans) Division of Research and Innovation. Phase 1 of this project focused on a needs assessment for California's national parks, and resulted in recommendations for ITS themes that may be applicable at GGNRA. Phase 2 of this project seeks to build on this foundation by facilitating deployment, including producing an ITS outreach video, developing measures of effectiveness for ITS in national parks, demonstrating and evaluating early winner projects.

Chapter 2 provides background into ITS, the National ITS Architecture, and the Caltrans-funded project. Chapter 3 discusses the architecture's scope. Chapter 4 provides an overview of the stakeholders involved in this architecture, while Chapter 5 is an inventory of existing and planned ITS for GGNRA. Chapter 6 discusses GGNRA's identified needs and the methodology that was used to identify ITS projects for GGNRA. Chapter 7 provides a detailed look at how a park's own architecture can be formed on the basis of identified needs and recommended ITS solutions, again by focusing on GGNRA. Chapter 8 discusses the implementation plan for this architecture. Chapter 9 will examine how GGNRA's ITS deployments may be integrated into the San Francisco Bay Area regional architecture maintained by the Metropolitan Transportation Commission (MTC). Chapter 10 will summarize this document and outline next steps.

2. BACKGROUND

The purpose of this chapter is to provide background on ITS, the ITS architecture, and the nature of this research project.

2.1. Definition of ITS

In an effort to address transportation challenges brought on by increased visitation, national parks are looking for solutions that will allow parks to continue to provide access to visitors while preserving park resources. Intelligent transportation systems (ITS) represent a class of solutions that may help national parks do that.

ITS may be defined as the application of advanced communications, information processing, control and electronics technology to improve the transportation system in order to save lives, time and money. ITS is an open-ended term that is not restricted to a fixed group of technologies or solutions, but rather characterizes the method of approach to solving a problem.

ITS as a term has gained popularity in recent years, especially in urban areas, to respond to increasing congestion without expanding roadway capacity. ITS has also found applicability for dealing with many transportation problems in rural areas, and is increasingly also being considered for national parks. National parks that are exploring ITS solutions to park challenges include the following:

- Acadia National Park (<u>1</u>, <u>2</u>)
- Cumberland Gap National Historical Park (<u>3</u>)
- Gateway National Recreation Area (<u>4</u>)
- Gettysburg National Military Park (<u>4</u>)
- Glacier National Park
- Grand Canyon / I-40/ Northern Arizona (<u>5</u>)
- Great Smoky Mountains National Park (<u>4</u>)
- Shenandoah National Park (<u>6</u>)
- Yellowstone National Park (7)
- Yosemite National Park (<u>4</u>)

2.2. Overview of National ITS Architecture

2.2.1. Definition

Implementing ITS typically requires multiple agencies to work together to achieve common goals. An ITS architecture is a way of ensuring that ITS can work with maximum efficiency within and between agencies.

An ITS architecture is a conceptual framework for how intelligent transportation systems may be designed and operated. From a design perspective, an architecture indicates the type of functions that are required, and consequently can help to define the technologies that may be most

appropriate. From an operational perspective, the architecture provides a framework that promotes the sharing of information efficiently and effectively between different stakeholders within the same agency or across organizations.

An ITS architecture is technology-neutral; in other words, it recommends neither a specific system design nor a design concept. Rather, the architecture defines the structure around which multiple design approaches can be developed. The ITS architecture defines:

- the functions that must be performed to meet stakeholder needs, such as gathering traffic information;
- the physical entities or subsystems where these functions occur, such as the roadside or the vehicle;
- the information flows between the physical subsystems; and
- the communication requirements for the information flows (e.g., wireline or wireless).

In addition, the architecture identifies and specifies the requirements for standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale considerations in deployment.

The National ITS Architecture is the nationally adopted standard for describing the interrelationship of organizations and systems under specific ITS projects. The architecture may be considered from three primary views:

- the logical architecture, which presents a functional view of ITS;
- the physical architecture, which partitions the functions reflected within the logical architecture into systems and subsystems where functions are actually performed; and
- communications, which connect the various systems.

An ITS solution may be developed without following the National ITS Architecture, but only at a significant cost. Ensuring that ITS solutions follow the National ITS Architecture provides the opportunity to access Federal funds, facilitates regional integration from an operational perspective, enables ITS systems to share a common "look and feel" for users, and facilitates staged implementation of projects.

2.2.2. Conformity

To be eligible for Federal funding, an ITS project must conform to a region's ITS architecture, which in turn must conform to the National ITS Architecture. Architecture development efforts in California mean that most, if not all, of the state's national parks are included in regions with conforming architectures. To demonstrate conformity, it is required that all ITS projects be developed using a systems engineering process. This process is an iterative approach that designs and plans systems based on operational requirements. For ITS projects, it is a Federal requirement that the following components of the systems engineering approach be included:

• identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of the National ITS Architecture);

- identification of participating agencies' roles and responsibilities;
- requirements definitions (what are the functional, operational, environmental and other requirements that must be met through the proposed project);
- analysis of alternative system configurations and technology options to meet requirements;
- procurement options;
- identification of applicable ITS standards and testing procedures; and
- procedures and resources necessary for operations and management of the system $(\underline{8})$.

2.3. Project Description

While several national parks have explored ITS solutions in a piecemeal fashion, there has not been a concerted, comprehensive effort to address national parks' transportation challenges and potential ITS solutions. At the same time, increasing visitation is resulting in a greater economic and transportation impact on parks and surrounding communities, potentially degrading the visitor experience, park resources and community goodwill.

In view of the beneficial role that national parks serve in California from quality of life and economic vitality perspectives and the potential that ITS offers to address transportation challenges at these parks, the California Department of Transportation (Caltrans) Division of Research and Innovation sponsored a research project to explore how ITS can help California's national parks. Caltrans pursued a two-phased research project. The first phase used two case study parks – Golden Gate National Recreation Area (GGNRA) and Sequoia and Kings Canyon National Parks – to identify transportation needs and recommend ITS solutions. The second phase of the project seeks to build on the first phase to provide concrete information to help parks advance toward implementation of ITS projects. Elements of Phase 2 include:

- Development of an outreach video on ITS in national parks
- A review of measures of effectiveness that may be appropriate for evaluating ITS in a national park setting
- Deployment and evaluation of early-winner projects at the case study parks
- A case study of how a national park's ITS might be integrated into its surrounding region

This report seeks to address the last question.

3. ARCHITECTURE SCOPE

This section presents information on the region that this architecture will encompass. It describes the need for this architecture, the boundaries of the region, and the covered timeframe.

3.1. Identify Need

GGNRA has realized the need for "soft" solutions such as ITS to increase access, reduce congestion, and improve safety on roadways leading to and adjacent to park sites. GGNRA has an ITS pilot project that will begin in the spring of 2005. GGNRA hopes that this project will be the first of many ITS applications used; therefore, there is a need to document these projects in an architecture.



When the San Francisco Bay Area ITS Plan, which included an update of the region's architecture, was completed in June 2004, GGNRA was not listed as a stakeholder. This architecture for GGNRA, therefore, is being created to build on the region's architecture. The architecture presented in this report will *not* be a stand-alone architecture; instead, it is hoped that the San Francisco Bay Area Regional architecture will incorporate relevant GGNRA ITS projects when it is updated.

3.2. Define Region

3.2.1. Geographic Region

The regional area/boundaries described in this architecture is the Golden Gate National Recreation Area (GGNRA) as shown in Figure 3-1. GGNRA is located on two peninsulas between the Pacific Ocean and San Francisco Bay, connected by the Golden Gate Bridge. The park is two and a half times the size of its neighboring city of San Francisco. GGNRA contains more than 28 miles of coastline and 75,400 acres of land and water. It is located in San Francisco, Marin, and San Mateo Counties.

3.2.2. Timeframe

The Federal Highway Administration (FHWA) requires that "the regional ITS architecture should look far enough into the future so that it serves its primary purpose of guiding the efficient integration of ITS systems over time" (9). For this reason, and in order to match the horizon of the San Francisco Bay Area Regional Architecture, this architecture is intended to reflect a ten-year timeframe.

4. STAKEHOLDERS AND CHAMPIONS

GGNRA has many different stakeholders who will be affected by and benefit from ITS in the park areas. The stakeholders that were involved in determining existing ITS devices, needs for the park and visitors, and ITS devices to deploy include counties, concessionaire, community-based organizations, emergency service providers, federal agencies, gateway communities, park partners, state agencies, regional agencies, and transit agencies. These stakeholders were engaged through outreach meetings that were held as part of the ITS Applications in California National Park project completed by the Western Transportation Institute (WTI) at Montana State University and the Comprehensive Transportation Management Plan (CTMP) for the Marin Headlands by Robert Peccia and Associates². A more detailed list of stakeholders is shown in Table 4-1.

A champion, according to FHWA, is the entity that will "drive the process that must occur in order to develop a regional ITS architecture and build consensus at each step of the development" (9). GGNRA and WTI will serve as the champions for this architecture until it is incorporated into the San Francisco Bay Area Regional Architecture, whose champion is the Metropolitan Transportation Commission (MTC).

² CTMP as originally designed was formally terminated by the Marin County Board of Supervisors in March 2005. However, GGNRA is continuing to work with Caltrans District 4, Marin County and other local stakeholders to implement projects and concepts outlined in the CTMP effort.

Table 4-1: Stakeholders

Type of Organization	Organization Name
Marin County	Marin County
	Marin County Bicycle Coalition
	Marin County Congestion Management Agency
	Marin County Convention and Visitors Bureau
San Francisco County	City and County of San Francisco
	San Francisco Bicycle Coalition
	San Francisco County Transportation Authority
	San Francisco Convention and Visitors Bureau
	San Francisco Department of Parking and Traffic
	San Francisco Recreation and Park Department
Concessionaires	Cliff House (Peanut Wagon Inc.)
	Muir Woods (Aramark)
Community-based	Muir Beach Association
Organizations	Planning Association of the Richmond District
	Presidio Residential Mayors' Council
	Presidio Tenants Council
	Stinson Beach Village Association
Emergency Services	California Dept. of Forestry (Santa Cruz/San Mateo)
	California Highway Patrol, Golden Gate Division
	National Park Service Park Police
Federal Agencies	Central Federal Lands Highway Division
_	Federal Highway Administration (California Division)
	National Park Service (NPS)
Gateway Communities	Larkspur
	Sausalito
	Muir Beach Community Service District
	Mill Valley
	Tamalpais Community Service District
Park Staff and Park	Golden Gate National Recreation Area Staff
Partners	Golden Gate National Park Conservancy
	Crissy Field Center
	Presidio Trust
	Fort Point and Presidio Historical Association
	Fort Mason Foundation
State Agencies	California Dept. of Transportation (Caltrans) Div. of Research and Innovation
_	California Chamber of Commerce
	California State Automobile Association
	California Travel and Tourism Commission
	California Dept. of Parks and Recreation Mt. Tamalpais State Park
Regional Agencies	California Dept. of Transportation (Caltrans) District 4
	Golden Gate Bridge, Highway and Transportation District
	Metropolitan Transportation Commission (MTC)
	Northern California Concierge Association
Transit Agencies	Alameda – Contra Costa Transit District
_	Bay Area Rapid Transit (BART)
	Blue and Gold Fleet (Alcatraz Ferry)
	Marin County Transit District
	RIDES for Bay Area Commuters
	Golden Gate Bridge Highway & Transportation District
	San Francisco Municipal Rail (MUNI)

5. INVENTORY OF SYSTEMS

A list of existing and planned ITS systems must be inventoried to ensure "development of interface requirements and information exchanges with these systems" (9). A comprehensive inventory of ITS deployments directly related to park operations and visitation is shown in Table 5-1.

Stakeholder	Element	Status	Architecture Entity
Caltrans	Closed Circuit Television (CCTV) to show park sites	Planned	Roadway Subsystem (subsystem)
Golden Gate National Recreation Area	Two Portable Changeable Message Signs (CMS)	Existing	Roadway Subsystem (subsystem)
	Traffic Counters	Existing	Roadway Subsystem (subsystem)
	Parking Occupancy Counters	Planned	Roadway Subsystem (subsystem)
	Kiosks / web-based information	Planned	Remote Traveler Support
Marin County Office of Emergency Services (MC-OES)	Highway Advisory Radio (HAR) near Mountain Home	Existing & Planned	Roadway Subsystem (subsystem)
Metropolitan Transportation Commission	Inclusion of GGNRA information on 511	Planned	Information Service Provider (subsystem)

Table 5-1: System Inventory

6. DETERMINE NEEDS AND SERVICES

This chapter details GGNRA's needs along with potential ITS services that will be implemented in the region. The ITS services are broken into three categories: ITS themes, candidate early-winner projects, and shorter-term projects identified through the Southwest Marin Comprehensive Transportation Management Plan (CTMP).³

6.1. Needs

FHWA recommends, "Before ITS services can be prioritized for the region, the problems with the regional transportation system and the associated needs of the operators, maintainers, and user of the system must be understood." (9) The challenges for GGNRA are displayed in the following sections by examining the visitation statistics, average daily traffic, vehicle classification, parking data, accident data, and operator/maintainer/visitor needs.

6.1.1. Visitation Statistics

Annual visitation statistics for GGNRA are shown in Figure 6-1. Total visitation for 2003 was over 14 million. The visitation at GGNRA remains fairly constant throughout the year; however, Muir Woods National Monument and most beach access areas have a peak in visitation during the summer.

³ The CTMP planning effort was ended as a formal process by Marin County in March 2005. Future ITS efforts both short and long-term – including those identified in this document – will be stand-alone efforts with independent value and utility. These projects are hence identified as Marin Parklands Transportation Planning Efforts.



Figure 6-1: GGNRA Visitation Statistics from 1980 to 2003

6.1.2. Average Daily Traffic

The average daily traffic (ADT) for roadways in the Marin County part of GGNRA was collected by Robert Peccia and Associates as part of the CTMP. The ADT for peak, shoulder and off-season weekday and weekend is shown in Table 6-1⁴. As can be seen, the ADT ranges greatly from 33,700 to 500, with the Shoreline Highway carrying the greatest amount of traffic (<u>10</u>).

⁴ Since this architecture is only for GGNRA, only the relevant information for roads to the National Park have been provided (i.e. state park information has been deleted from the original table).

						Off-	Off-
		Peak	Peak	Shoulder	Shoulder	Season	Season
Road	Segment	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Shoreline	101-Coyote Cr. Br.	33,700	33,000	31,000	29,100	28,300	24,200
Shoreline	Coyote Cr. BrTam Jct.	29,700	28,700	28,700	27,100	26,000	22,200
Shoreline	Tam JctLoring Ave	18,600	21,100	17,000	19,500	15,000	17,000
Shoreline	Loring Ave- Panoramic	6,900	12,800	4,200	7,900	3,800	6,000
Shoreline	Panoramic–Muir Woods Rd.	3,800	7,000	2,500	5,600	2,300	3,500
Shoreline	Muir Woods Rd Panoramic (just north of Muir Beach)	2,300	4,700	1,600	3,700	1,500	2,400
Shoreline	Muir Woods Rd Panoramic (just south of Panoramic near Stinson)	1,900	4,000	1,500	3,600	1,500	3,000
Shoreline	Panoramic-Stinson Beach Entrance	4,800	7,100	3,100	5,800	2,700	3,200
Shoreline	North of Stinson Beach Entrance	3,100	4,800	2,500	3,700	2,100	2,600
Tennessee Valley	Shoreline-Enterprise Rd.	7,800	8,500	7,000	7,600	4,500	4,900
Tennessee Valley	Enterprise Rd Parking Area	1,100	1,800	1,000	1,500	900	1,200
Panoramic	Shoreline –Four Corners	3,200	5,500	2,400	4,500	2,200	2,500
Panoramic	Four Corners- Mountain Home	4,300	6,000	4,000	5,800	3,800	3,300
Panoramic	Mountain Home-Pan Toll	2,500	4,200	2,000	3,900	1,800	2,700
Panoramic	Pan Toll-Shoreline	2,000	2,900	1,600	2,300	1,400	1,700
Muir Woods	Four Corners-Muir Woods N.M.	1,400	2,500	900	1,800	900	1,500
Muir Woods	Muir Woods N.M. – Shoreline	1,000	1,400	600	900	500	800

Table 6-1	Average	Weekday	and V	Neekend	Daily	Traffic	Summary
	Average	WCChuay	anu	V CCKCHU	Dany	11 anne	Summary

Source: <u>10</u>

6.1.3. Vehicle Classification and Occupancy Data

The CTMP study also included a vehicle classification study. As can be seen in Figure 6-2, the majority (86.5 percent) of motorists traveling on Shoreline Highway (the highway with the most ADT in the Marin County part of GGNRA) travel via passenger cars, pickup trucks, and SUVs. Vehicle occupancy was measured at Tennessee Valley, Muir Woods, Muir Beach, and Stinson Beach. The average occupancy range was 1.34 to 2.66 with an overall average around two people per vehicle. Muir Woods had the greatest vehicle occupancy (2.6 people), which is not surprising due to the higher percentage of tourists visiting Muir Woods compared to local residents visiting other sites ($\underline{10}$).



6.1.4. Parking Data

As shown in Table 6-2, the parking study done by Robert Peccia and Associates shows that the GGNRA sites in Marin County have a total of 1,575 parking spaces. It should be noted that only Muir Woods has parking spaces available for buses. Their parking utilization study shows that the demand for parking spaces always exceeds the supply in Tennessee Valley (235 percent), Muir Woods (250 percent), Muir Beach (107 percent), and Stinson Beach (124 percent). Many times, these vehicles are parking on the shoulders, damaging valuable resources and creating unsafe conditions.

Parking Area	Surfacing	Delineated Spaces	Automobile Capacity	Handicap Spaces	Bus Spaces
Manzanita/Felton*	Paved	Yes	362	10	0
Tennessee Valley	Dirt/Gravel	No	86 +/-	0	0
Muir Woods-Main	Paved	Yes	81	6	10
Muir Woods-Overflow	Paved	Yes	98	0	0
Muir Beach	Dirt/Gravel	No	175 +/-	2	0
Stinson Beach-North	Paved	Yes	179	3	0
Stinson Beach-Central	Paved	Yes	141	4	0
Stinson Beach-South	Dirt/Sand	No	500 +/-	0	0

Table 6-2: Parking Inventory Summary

* These sites are not on NPS lands and are not near park attractions, but they are included because of their potential as intercept sites that could accommodate parking for some visitors who would visit the park via transit. Currently, only a very limited transit service serves the Marin areas of GGNRA.

Source: <u>10</u>

6.1.5. Accident Data

As can be seen in Table 6-3, the average accident rates for roads in Marin county range from 0.90 to 9.69 accidents per million vehicle-miles traveled. When compared to accident rates for similar roads in California, over half (8 of 14) of the road segments within this area have an accident rate greater than comparable roadways.

		Accident Rate (per million VMT) 1999-2001		
			Statewide for Similar Road	
Corridor	Segment	Recorded	Туре	Description
Shoreline Hwy.	U.S. Hwy. 101-Coyote Cr. Br.	2.29	2.95	Suburban 2-lane highways, speeds less than 45 mph
Shoreline Hwy.	Coyote Cr. BrFlamingo Rd. (Through Tam. Jct)	9.69	4.95	Urban 4-lane highways, speeds less than 45 mph
Shoreline Hwy.	Flamingo RdLoring Rd.	2.87	2.95	Suburban 2-lane highways, speeds less than 45 mph
Shoreline Hwy.	Loring RdPanoramic Hwy. (3 corners)	2.19	1.78	Mountainous 2-lane highways, speeds less than 55 mph
Shoreline Hwy.	Panoramic Hwy (3 corners)-Muir Woods Rd.	1.55	1.78	Mountainous 2-lane highways, speeds less than 55 mph
Shoreline Hwy.	Muir Woods Rd Panoramic Hwy. (north)	1.07	1.78	Mountainous 2-lane highways, speeds less than 55 mph
Shoreline Hwy.	Panormaic Hwy.(north)- North of Calle Del Arroyo (Stinson Beach)	3.21	2.95	Suburban 2-lane highways, speeds less than 45 mph
Muir Woods Rd.	Panoramic HwyMuir Woods	2.10	1.65	Conventional 2-lane mountainous roads with at least 400 vehicles per day
Muir Woods Rd.	Muir Woods-Shoreline Hwy	0.90	1.30	Conventional 2-lane rolling roads with at least 350 vehicles per day
Panoramic Hwy.	Shoreline Hwy (3 corners)-Muir Woods Rd. (4 corners)	3.12	1.30	Conventional 2-lane rolling roads with at least 350 vehicles per day
Panoramic Hwy.	Muir Woods Rd. (4 corners)-Mountain Home	1.26	1.30	Conventional 2-lane rolling roads with at least 350 vehicles per day
Panoramic Hwy.	Mountain Home-Pan Toll Rd.	1.36	1.30	Conventional 2-lane rolling roads with at least 350 vehicles per day
Panoramic Hwy.	Pan Toll RdShoreline Hwy.	1.73	1.65	Conventional 2-lane mountainous roads with at least 400 vehicles per day
Tenn. Valley Rd.	Shoreline HwyParking Area	6.08	1.65	Conventional 2-lane mountainous roads with at least 400 vehicles per day

Table 6-3: Accident Rate Comparison

Source: <u>10</u>

6.1.6. Operator/Maintainer/Visitor Needs

Transportation needs for GGNRA were identified through outreach meetings, visitor surveys, and a review of planning efforts conducted as part of phase 1 of the Caltrans research project.

GGNRA's needs are summarized in the following paragraphs, and are described in more detail in Chapter 6 of the technical report for Phase 1 (<u>11</u>).

- <u>Roadway Congestion</u>. Roadway congestion occurs during high visitation times at many locations throughout the recreation area, including the Route 1 Corridor, Conzelman Road, Rodeo Beach, the Marin Headlands, Vista Point, the south end of Golden Gate Bridge, 19th Avenue/Park Presidio Boulevard, Stinson Beach, Crissy Field/Bay Street, Fort Baker and Muir Woods. Sausalito has expressed concern about the additional traffic impacts when Fort Baker is transferred from the U.S. Army to the National Park Service.
- <u>Inadequate Access</u>. There is a desire to improve access to various park sites, including Crissy Field, Doyle Drive, various sites within Presidio, in addition to neighborhoods, museums and other local attractions where automobile access is limited. This problem includes insufficient amenities and facilities for pedestrians and bicyclists to access and use park facilities.
- <u>Limited Parking</u>. Overflow visitor parking is a challenge at several GGNRA locations, including Muir Woods, Stinson Beach, Conzelman, Rodeo Beach, Vista Point, Fort Mason and Fort Baker. At Muir Woods, for example, parking may back up one mile from the park entrance onto adjacent two-lane roadways which are not designed to support on-street parking. There is a lack of real-time information regarding parking availability and advance information about when crowded conditions might be expected. There is also concern about employee parking as the Presidio continues to be developed.
- <u>Transit Coordination and Information</u>. The dispersed lands associated with GGNRA may make it difficult for a tourist to access park lands without an automobile. The variety of transit services in the Bay Area, plus the numerous other cultural, educational and recreational attractions in the area, provide an opportunity for coordinating transit service to improve the level of service and access to GGNRA lands. There is a need to improve information about transit service at park sites as well, to inform travelers of available transit options, their schedules, and their estimated arrival times.
- <u>Lack of Planning Data</u>. There is a need for improved data regarding visitation patterns in order to improve transportation planning for park lands and adjacent communities and neighborhoods. There is also a lack of data regarding visitor travel by non-motorized means, although there is limited ability to collect this data automatically.
- <u>Traveler Information</u>. There is a need to provide tourists with information about parking, congestion, transit availability and weather prior to their visit, along with improved information about activities within the park as well as in surrounding areas. Ideally, this could be done with a predictive element to allow for better planning and management of

visitor traffic. This traveler information needs to reach people in systems they will use and at locations that enable them to make appropriate decisions.

- <u>Work Zone/Event Coordination</u>. There is need for better coordination between agencies on work zones and construction, and providing information on actual versus planned lane closures. In addition, there are often special events that significantly impact traffic levels on roadways providing access to park sites. In some cases, estimated traffic impacts of events are reported to some agencies but are not distributed to all affected agencies.
- <u>Emergency Response</u>. The park must be sensitive to evacuation and emergency response needs on its lands. There will be a need to ensure rapid coordination and dispatch of appropriate resources to respond to large-scale emergencies, and to provide visitors and others with appropriate information to allow them to alter their travel behavior and visitation activities as needed.

6.2. ITS Services

In order to ensure that ITS deployments are integrated, it is important that they be related to the National ITS Architecture. To ensure that ITS deployments meet actual stakeholder needs, however, it is important that the ITS projects can be traced back to addressing specific needs.

Phase 1 of the Caltrans research project followed the process shown in Figure 6-3 to develop ITS themes for the case study parks. Transportation problems, and an assessment of the potential benefits of ITS improvements, were used to develop a list of ITS objectives for national parks. Based on each park's needs, ITS themes were developed to meet various combinations of the ITS objectives. ITS themes are used to describe in broad terms what ITS may accomplish in a national park setting. Once these themes were developed, the research team analyzed how these themes could fit into the National ITS Architecture.



Phase 2 of the Caltrans research project resulted in the generation of ideas for early-winner projects. The ITS themes were used as the basis for developing early-winner project ideas; however, since the purpose of these project ideas was to find a project deployable within the funds of the research project, themes that would result in higher cost projects were not developed. The early-winner project ideas, therefore, may make the most sense for the park to implement in the short-term.

The purpose of this section, then, is to trace how transportation needs identified for GGNRA were developed into early-winner project ideas.

6.2.1. ITS Themes

Seven ITS themes were developed for GGNRA on the basis of the needs that were listed in the previous section. These themes are as follows.

- <u>Roadway Congestion Forecasting</u>. This ITS theme involves utilizing information on current roadway conditions, along with archival information on "normal" traffic characteristics and the anticipated impacts of special events and construction, to assess current and near-term congestion levels. This information would assist park managers in preparing for congestion activity, and would help visitors to better plan their trips to park sites.
- <u>Data Collection and Storage</u>. This theme would involve collecting and organizing all relevant data (including weather, traffic volumes, transit utilization) in a manner that is useful to local and regional National Park Service staff and others who would benefit from this information.
- <u>Parking Management and Information</u>. This ITS theme involves the fusion of real-time information about parking availability along with historical information about parking occupancy and turnover to estimate current and future parking availability at parking facilities throughout the park. Real-time information would be collected through automated systems that would communicate the information to a central location. Parking availability information could be conveyed to visitors through a variety of means, including park rangers, visitor centers, kiosks, and the Internet. This information could also be communicated via changeable message signs (CMS) to park-and-ride sites located away from the park, which could encourage visitors to switch to transit.
- <u>Parking Intercept</u>. This ITS theme would involve park staff using information on current congestion and parking availability to provide information to locations where drivers could park and then take transit. Information could be provided using Highway Advisory Radio (HAR) or CMS at decision points to direct drivers to parking lots where they could use transit. The parking lots would then have information on the availability and real-time arrival schedule of transit.
- <u>Pre-Trip Traveler Information</u>. This ITS theme involves collecting and distributing all information that would help visitors enjoy their experience at GGNRA. It would provide a mix of static and dynamic information to assist them in planning their itinerary to and between GGNRA sites, along with nearby tourist attractions. The information would include travel time (reflecting congestion and construction activities), weather and parking information for GGNRA sites. It would also include information on transit and non-auto alternatives. It would also provide links to more detailed information about GGNRA sites along with other attractions that may be of interest to visitors.
- <u>Transit Trip Planning</u>. In conjunction with Bay Area transit agencies, this ITS theme would promote the coordination of transit schedule and vehicle location information to provide real-time information about transit service to various park sites. This feature

would allow visitors to develop itineraries, and would allow visitors to factor in any special needs (e.g. bringing a bicycle) that may affect which services they can use.

• <u>Major Emergency Response</u>. This ITS theme would help park management to respond to catastrophic man-made or natural disasters. Its primary emphasis would be evacuation of visitors in a safe and efficient manner to ensure their safety while allowing emergency response activities to continue. This theme would also allow for communication between emergency responders and park police as needed to ensure a coordinated response between all regional parties.

For each theme, the phase 1 report provided a diagram showing how information would flow between different organizations and agencies to support the theme's functionality, scenarios to describe how the themes would affect park visitors and management, descriptions of several alternative technology implementations for the theme, and an overview of institutional and technical issues that may affect theme implementation.

The phase 1 report mapped the ITS themes against the market packages and user services defined in the National ITS Architecture. The results of this mapping are shown in Table 6-4.

ITS Themes	User Services	Market Packages
Roadway Congestion Forecasting	1.6 – Traffic Control 7.1 – Archived Data Function	 AD2 – ITS Data Warehouse ATMS01 – Network Surveillance ATMS09 – Traffic Forecast and Demand Management MC04 – Weather Information Processing and Dissemination MC08 – Work Zone Management
Data Collection and Storage	7.1 – Archived Data Function	AD1 – ITS Data Mart AD2 – ITS Data Warehouse
Parking Management and Information	1.1 – Pre-trip Travel Information 1.5 – Traveler Services Information	AD2 – ITS Data Warehouse ATMS06 – Traffic Information Dissemination ATMS16 – Parking Facility Management ATMS17 – Regional Parking Management
Parking Intercept	1.2 – En-route Driver Information 1.5 – Traveler Services Information	APTS1 – Transit Vehicle Tracking APTS8 – Transit Traveler Information ATMS06 – Traffic Information Dissemination ATMS16 – Parking Facility Management ATMS17 – Regional Parking Management
Pre-Trip Traveler Information	 1.1 – Pre-trip Travel Information 1.5 – Traveler Services Information 2.2 – En-route Transit Information 8.1 – Maintenance and Construction Management 	 APTS1 – Transit Vehicle Tracking ATIS2 – Interactive Traveler Information ATMS01 – Network Surveillance ATMS09 – Traffic Forecast and Demand Management
Transit Trip Planner	1.1 – Pre-trip Travel Information 2.2 – En-route Transit Information	APTS1 – Transit Vehicle Tracking APTS8 – Transit Traveler Information ATIS2 – Interactive Traveler Information
Major Emergency Response	 1.2 – En-route Driver Information 1.7 – Incident Management 	ATIS1 – Broadcast Traveler Information ATMS06 – Traffic Information Dissemination ATMS08 – Incident Management System EM1 – Emergency Response

Table 6-4: Mapping of ITS Themes to National ITS Architecture

(Source: <u>11</u>)

6.2.2. Early-Winner Projects

Eight ideas were developed as potential early-winner projects for the park. These ideas were developed in the context of meeting park needs, working within limited funding, and adhering to a short project schedule. These project ideas include the following (see <u>12</u> for more details).

- <u>Shared-use CMS at US Route 101 and State Route 1 Interchange</u>. This project would involve the deployment of two CMS on US Route 101 approaching the interchange of US Route 101 and State Route 1. The signs could be used to help relieve congestion at the interchange, to warn motorists of full parking lots or congested conditions at Muir Woods and Stinson Beach.
- <u>Park-wide Radio System</u>. This project would look to install a park-wide radio system with potential locations to include Fort Mason, the Presidio, Lands End, US 101 at the north end of the Golden Gate Bridge, US 101 at the interchange of US 101 and SR 1, Muir Woods and Stinson Beach. This system would improve the en-route traveler information by providing automated recording capabilities, which can provide more detailed, real-time information while reducing staffing requirements, and provide real-time indications to motorists of when information is available. Such a system would allow the park flexibility that it would not have by simply piggy-backing on other agencies' existing systems. The park would be able to use this system whenever needed, put any message deemed necessary on the system, and provide significantly more information than can be conveyed on a CMS.
- <u>Muir Woods/Stinson Beach Cameras</u>. The need for better information on parking and weather at both Stinson Beach and Muir Woods, as well as visual information about congestion at the Manzanita exit from US 101 and SR1, and entering Stinson Beach on SR1, leads to the idea of installing remotely controlled (pan-tilt-zoom) closed circuit television (CCTV) cameras. Images from these cameras would be sent directly to the GGNRA webpage, and to Caltrans' Transportation Management Center, and therefore would be accessible to both visitors and park rangers.
- <u>NextBusTM/AVL for Muni and GGT</u>. Currently, transit providers in the San Francisco Bay Area are equipping their bus routes with automatic vehicle location systems (AVL) and the NextBusTM technology to be able to track buses and provide real-time information about the arrival time of the next bus to transit users. The arrival time information will be displayed at the bus stop on changeable message signs, on the Internet, and on the 511 system. The two transit routes that serve GGNRA are scheduled to be in the last round of deployment, meaning that it could be two or more years before they are equipped with this system. This project would accelerate equipping these two routes.
- <u>Reservation System for Parking at Muir Woods and Stinson Beach</u>. This project would allow GGNRA to manage parking capacity at Stinson Beach and Muir Woods. With a seasonal reservation system in place, visitors would potentially need to call in advance to schedule a parking space at one of the these two very popular GGNRA locales. This would help visitors by insuring space or informing them of the need to take transit. It would also help manage the congestion and overflow parking at these two sites, improving visitor satisfaction and, at Muir Woods, pedestrian safety, while decreasing congestion on roadways.
- <u>Park Information Database and Integration with 511</u>. Improving information dissemination to park visitors requires not only an infrastructure to get information out

(i.e. kiosks, changeable message signs, Internet sites, highway advisory radio, telephone number), but also accurate real-time information. To get information out efficiently, the time required to collect, analyze and re-package data should be minimized. One effective way to do this is to develop a common database for all traveler information that may be useful to park visitors. The database can serve as a source of information for a variety of information outlets, and can provide capabilities for automation that can help to reduce the time park personnel need to spend in collecting and analyzing data on a real-time basis.

- Event Management at Fort Mason and Crissy Field. Many events take place at Fort Mason and Crissy Field in GGNRA. Improving event management for park visitors requires policies and procedures for park staff along with documenting lessons learned both positive and negative from past events. As the turnover of park volunteers occurs every summer, the chances of having a group of experienced staff assigned to an event are pretty minimal. This document would help to fill these gaps in experience and assure a more efficient event management.
- <u>Pedestrian/Bicycle Trail Plan for GGNRA</u>. With congestion in San Francisco in general and parking constraints at most GGNRA sites, alternative transportation connections need to be addressed. This project would deploy a test ITS application.

The relationship of these early-winner projects to the earlier mentioned themes and needs are graphically shown in Figure 6-4. As can be seen, the projects were selected to partially address most of the transportation needs that were identified for the park.

6.2.3. Projects from Marin Parklands Transportation Planning Efforts

In addition to the ITS Applications in California National Parks Project (Phases 1 and 2), the park is intending to implement ITS initiatives in the near-term based on the recommendations from the Marin Parklands transportation planning efforts, including the CTMP (<u>13</u>). Some of these projects overlap with the ITS themes and early-winner projects that were presented in the Phase 1 Report. The Parklands transportation planning projects are listed in Table 6-5.



Figure 6-4: Traceability between Needs, ITS Themes and Early-Winners for GGNRA

Technology	Locations	Description of Operation	
Existing Systems			
Highway Advisory Radio (HAR)	Transmitter near Mountain Home, signal reaches to Stinson Beach, Muir Beach, and Loring Avenue (SR 1) on good days	 System currently owned by Marin County Office of Emergency Services (MC-OES). GGNRA has permission to post messages for road and congestion information, provided MC-OES does not have higher priority GGNRA can activate messages using land-line or cell telephone, with pre-programmed or custom messages 	
511	Regionwide, administered by Metropolitan Transportation Commission	 GGNRA provides congestion info to MTC, who may put it on their system 	
Future Systems			
Additional HAR	 The CTMP suggests adding HAR sites at: Lombard and Scott before Doyle Drive 19th Ave near Geary 101 NB between Golden Gate Bridge and Waldo Tunnel 101 NB & SB exit ramps at Manzanita Shoreline Hwy between Manzanita and Tenn. Valley SR 1 at Dolan SR 1 just east of Panoramic Hwy near Dias Ridge Sequoia Valley Road near 4 Corners Near 2 AM Club in Mill Valley Upper and lower approaches to Muir Woods North and south approaches to Stinson Beach Other sites as recommended by HAR consultant 	GGNRA would activate and de- activate messages	
Flip Signs	En-route to all park sites and at the entrance to all major parking areas	 These signs will be manual flip signs that will allow GGNRA staff to warn motorists of full parking lots en-route and at the site. 	

Table 6-5: Short-term ITS Projects for GGNRA

Technology	Locations	Description of Operation
Future Systems (cont.)		
Closed-circuit Television (CCTV) Cameras	 At selected park sites to show weather and parking At key road locations to show traffic flow 	 Caltrans will have control over cameras to adjust their view area Caltrans will post images onto their traffic web site to tie road congestion information into their sub-regional system Data from images would be available to add to 511 system (MTC) or post to permanent CMS (Caltrans) GGNRA will get a link to use these images on their web site
Traffic Counters	At the entrance to all major parking area	 GGNRA would receive data at park headquarters Data would be available to MTC for 511 system
Parking Occupancy Counters	Parking lots at specific sites	 GGNRA would receive data at park headquarters May post data to website, or share with partner agencies
Kiosks	Main park destinations	 Provide access to the web site for visitor information

Table 6-5: Short-term ITS Projects for GGNRA (cont.)
7. PARK-LEVEL ARCHITECTURE

The purpose of this chapter is to develop a park-level architecture⁵ based on the Marin Parklands transportation planning efforts' projects, early-winner projects, and ITS themes that were presented in Chapter 3. First, projects documented in the joint Parklands transportation effort will be added as these are most likely to happen. Early-winner projects will be added onto this. Finally, ITS themes will be added onto that. This chapter will discuss the operational concept, functional requirements, interconnects, and informational flows for the ITS projects.

7.1. Parklands Transportation Planning Elements

Figure 7-1 provides a schematic showing the information flows that are projected under full implementation of the Marin Parklands transportation planning projects. This reflects a combination of three market packages from the National ITS Architecture: Network Surveillance (ATMS01), Traffic Information Dissemination (ATMS06), and Regional Parking Management (ATMS17). The boxes in the diagram refer to specific physical entities within the National ITS Architecture. These entities are defined for GGNRA in Table 7-1.



Stakeholder	Entity	Description		
CT – Caltrans District 4	Roadway	 Consists of field equipment, including: Surveillance cameras Changeable message signs Traffic detectors 		
	Traffic Management	 Operate surveillance cameras, view images, and provide information to 511 and website Provide message content to HAR Review status of HAR to make sure they are operating correctly Analyze traffic data to assess congestion and traffic patterns 		
	Traffic Operations Personnel	 Provide human element to make sure traffic management functions are accomplished 		
MC – Marin County	Roadway	Consists of field equipment, including: • HAR		
MTC - Metropolitan Transportation Commission	Information Service Provider	Provide travel information to travelers via a 511 telephone number and affiliated web site		
NPS - National Park Service (GGNRA)	Parking Management	 Consists of: field equipment measuring parking lot occupancy, <u>or</u> / and a camera image showing parking lot occupancy, <u>or</u> / and a human observer 		
	Remote Traveler Support	Provide travel information to travelers via a kic		
	Roadway	Consists of field equipment, including: Surveillance cameras Flip Signs (GGNRA owned) Traffic detectors 		
	Traffic Management	 Operate surveillance cameras, view images, and provide information to 511 and website Provide message content to HAR Review status of HAR to make sure they are operating correctly Analyze traffic data to assess congestion and traffic patterns 		
	Traffic Operations Personnel	Provide human element to make sure traffic management functions are accomplished		
Public	Basic Vehicle	Receive information regarding traffic and parkin conditions at GGNRA		
	Driver	Receive information regarding traffic and parkin conditions at GGNRA		
	Traveler	Receive information regarding traffic and parking conditions at GGNRA		

The red-shaded information flows refer to the use of flip signs and highway advisory radio to provide information to motorists. The HAR is the existing radio station operated by Marin County Office of Emergency Services.

The orange-shaded information flows relate to the operation of closed-circuit television (CCTV) cameras showing images of various park sites and roadways. It is currently proposed that Caltrans will own and operate these cameras, and will post images on their web site. It is envisioned that the park will consult Caltrans on a case-by-case basis to pan the camera images to see different locations. For example, Caltrans may have a camera positioned to overlook State Route 1 on the way to Stinson Beach, but the park may request that the camera zoom in on parking areas at the beach. Joint control of the camera is possible, but GGNRA and Caltrans would need to formalize an agreement about the roles and responsibilities of each organization.

The yellow section refers to traffic counters that would be positioned on roadways accessing park lands. GGNRA or Caltrans would receive data regarding traffic flow, which could be used to help manage congestion.

The green-shaded information flow indicates that GGNRA or Caltrans would be responsible for providing information on park-related congestion to 511. Currently, this would be done through a human interface. In the future, protocols may be developed to automate this. For example, it may be set up so that if certain parking thresholds are exceeded that this will be automatically posted on a certain portion of the 511 system.

The blue-shaded information flows relate to the tracking of parking lot occupancy. This can be done on a human-intervention basis, where park staff could communicate with personnel stationed at various parking lots to track availability. For some parking lots, this could be implemented in a more automated fashion, where field equipment can track the number of vehicles entering and leaving a given parking area.

The lavender-shaded information flows represent the human interface related to projects from the Marin Parklands transportation planning effort. The current concept of operations has park personnel responsible for making decisions on how to respond to data regarding current and future congestion as they receive it (i.e. post and remove messages from a CMS).

The brown-shaded information flows refer to kiosks that would be positioned outside of major park destinations. GGNRA would provide the data for these kiosks via their park website.

As these projects get implemented, the following key questions must be addressed:

- Will Caltrans and GGNRA share control of cameras? How would they share control will Caltrans normally have control and GGNRA can control them on an exception basis (with a phone call)?
- Is there a more efficient way of getting data onto MTC's 511 system other than a human interface?

• What other CMSs would be available for GGNRA messages? What are the protocols for GGNRA being able to post messages onto these signs?

7.2. Early-Winner Projects

Figure 7-2 is an interconnect diagram, showing all of the entities that would need to be in place to support the functionality of all candidate early-winner projects identified in the feasibility study. These entities are named according to the terminology of the National ITS Architecture. There may be opportunities for some of the entities to be combined within the same office of an organization. The entities are defined in Table 7-2.

The connections between entities shown in this figure can help to ensure that design of new ITS systems takes into account the full functionality that may eventually be desired. This is especially critical when there are connections between different organizations. Table 7-3 lists these inter-organizational connections, describing the type of data-sharing requirements that may be involved. This can be helpful for identifying the memoranda of understanding and supporting policies that may be needed as ITS implementation progresses.

Appendix A provides figures and tables showing the specific information flows that apply to each early-winner project.



Figure 7-2: Early-Winner Projects, Interconnect Diagram

Table 7-2: Description of Stakeholder	rs, Early-Winner Projects
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Stakeholder	Entity	Description		
NPS/GGNRA	Archived Data Management	Data archive that would be used by GGNRA staff to help predict and plan for congestion due to favorable weather, special events, construction, etc.		
	Information Service Provider	Provides GGNRA with the capability of posting camera images onto a web site, providing an interface to assist visitors with making parking reservations, and serving as a central database for dissemination of information to park visitors.		
	Parking Management	Responsible for the management and monitoring of GGNRA parking lots. This could also include tracking parking lot occupancy and regulating vehicle entry based on a reserved permit system.		
	Roadway	Includes vehicle detectors, cameras, changeable message signs, real-time pedestrian and bicycle crossing systems, and other roadside infrastructure owned and operated by GGNRA.		
	Traffic Management	Represents the part of the park which is responsible for traffic operations on a day-to-day basis. This would include monitoring and responding to congestion.		
	Traffic Operations Personnel	Park personnel who make real-time decisions regarding appropriate traffic management strategies for the park.		
Caltrans D4	Roadway	Includes vehicle detectors, cameras, changeable message signs, and other roadside infrastructure owned and operated by Caltrans.		
	Traffic Management	Represents the Caltrans TMC in Oakland, which is responsible for traffic operations on a day-to-day basis throughout Caltrans District 4. Includes monitoring and responding to congestion. This center may need to coordinate with park management for effective collection and dissemination of data.		
MTC – 511	Information Service Provider	Provides information content for the MTC's 511 telephone information number and MTC's traveler information web site.		
	Telecom System for Traveler Information	Represents the 511 telephone interface into which travelers can dial for real-time traveler information.		
GG Transit/ SF Muni	Remote Traveler Support	Represents electronic real-time displays at bus stops and terminals which convey information about the current bus schedule and the expected arrival time of the next bus.		
	Transit Management	Tracks the location of transit vehicles operated by each service in order to provide real-time information on vehicle arrival times.		
	Transit Vehicle	Represents a vehicle operated by either service which has on- board equipment to assist in identifying vehicle location.		
	Vehicle	Represents the vehicle's location.		

Stakeholder	Entity	Description		
Public	Basic Vehicle	Includes vehicles driven by the general public, and the extent to which they can receive information from highway advisory radio (through a vehicle-based radio)		
	Driver	Includes drivers who would receive visual information from changeable message signs, and also respond to other roadside- based systems (for example, a dynamic pedestrian crossing warning system)		
	Event Promoters	Plan events at or near GGNRA sites such that there will be a significant traffic impact. Responsible for coordinating traffic management strategies with GGNRA.		
	Pedestrians	Includes bicyclists and pedestrians on trails in and between parklands. Intelligent infrastructure – pedestrian crossing systems – will allow the pedestrians and bicyclists to cross a vehicle roadway safely. May be required to activate the warning, or detection could be set up to note the presence of a pedestrian or bicyclist automatically.		
	Personal Information Access	Handheld devices that a traveler may use to make a reservation for a parking space at a park site, or obtain other real-time visitor information from the park.		
	Remote Traveler Support	Kiosks, public web sites, or even a hotel concierge, that a traveler may use to make a reservation for a parking space at a park site, or obtain other real-time visitor information from the park.		
	Traffic	Flow of vehicles as recorded by traffic detectors and surveillance cameras.		
	Traveler	Visitor who either is viewing information at a public kiosk or bus stop regarding the next bus' arrival time, or is using a kiosk or personal device to access real-time information on the park.		
	Traveler Card	Used by the traveler to pay for parking reservations at Muir Woods, if the parking reservation early-winner project is implemented.		
	Vehicle	System on vehicles that uniquely identifies them to allow reserved access into GGNRA parking areas.		
Other	Environment	Current weather conditions as shown by a camera image.		
	Financial Institution	Financial institutions from which funds would be electronically debited to pay for parking reservations.		
	Weather Service	Current conditions and short-term forecast information related to various sites within GGNRA.		

Entity Pair	Type of Relationship		
GGNRA Information Service Provider and MTC-511 Information Service Provider	 GGNRA provides information to MTC 511 that can be put on 511 telephone or MTC web site MTC-511 provides information that can be placed on GGNRA's web site and park information telephone number 		
GGNRA Traffic Management and MTC-511 Information Service Provider	 GGNRA provides information to MTC 511 that can be put on 511 telephone or MTC web site 		
GGNRA Traffic Management and Caltrans District 4 Traffic Management	 Caltrans and GGNRA map post messages on each others CMS and HAR Caltrans may provide GGNRA with traffic data for archiving and use in forecasting congestion GGNRA and Caltrans may share information on anticipated traffic impacts of special events 		
GGNRA Information Service Provider and GG Transit/SF Muni Transit Management	 The transit agencies provide information about current arrival status for routes serving park lands, in a format where it can be automatically provided via other park information outlets 		

7.3. ITS Themes

Figure 7-3 is an interconnect diagram, showing all of the entities that would need to be in place to support the functionality of the ITS themes identified in the Phase 1 report. These entities are named to highlight compatibility with the National ITS Architecture. There may be opportunities for some of the entities to be combined within the same office of an organization. The entities are defined in Table 7-4.

The connections between entities shown in this figure can help to ensure that any design of new ITS systems takes into account the full functionality that may eventually be desired. This is especially critical when there are connections between different organizations. Table 7-5 lists these connections, describing the type of data-sharing requirements that may be involved. This can be helpful for identifying the memoranda of understanding and supporting policies that may be needed as ITS implementation progresses.

Appendix B provides figures and tables showing the specific information flows required for each ITS theme.



Figure 7-3: ITS Themes, Interconnect Diagram

Park-Level Architecture

Stakeholder	Division	Entity	Description
CT - Caltrans District	Transportation Planning	Archived Data User Systems	Uses data collected by GGNRA
	Highway Operations / Maintenance	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park
	Highway Operations / TMC	Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers
	Highway Operations / TMC	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs
ER -Emergency Response	Local Public Safety Answering Point (PSAP)	Emergency Telecomm. System	911 or other service that provides information about emergencies
	California Highway Patrol San Francisco or Marin	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites
	City/County of San Francisco Police Department and Sheriff's Department	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites
	Local Law Enforcement	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites
	Marin County Sheriff's Office	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites
GGT - Golden Gate Bridge, Highway and Transportation District	Golden Gate Bridge	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park
	Golden Gate Transit	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)
	Golden Gate Bridge	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs

Stakeholder	Division	Entity	Description
Golden Gate Bridge, Highway and Transportation District (cont.)	Golden Gate Transit	Transit Management	Manages and operates transit routes serving park sites, parking intercept lots, and other regional destinations
	Golden Gate Transit	Transit Vehicle	Provides transit access to GGNRA park sites and intercept lot
	Golden Gate Transit	Vehicle	Vehicle equipment of transit vehicle
MC – Marin County	Department of Public Works / Roads	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park
	Department of Public Works / Traffic	Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers
	Department of Public Works / Traffic (Office of Emergency Services for HAR)	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs
MCT - Marin County Transit	Board of Supervisors / Marin County Transit	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)
	Board of Supervisors / Marin County Transit	Transit Management	Manages and operates transit routes serving parking intercept lots
	Board of Supervisors / Marin County Transit	Transit Vehicle	Provides transit access to GGNRA park sites and intercept lot
	Board of Supervisors / Marin County Transit	Vehicle	Vehicle equipment of transit vehicle
Metropolitan Transportation Commission	511 / TravInfo / TakeTransit.org	Information Service Provider	Collects and repackages information to make it useful to visitor
	511	Telecomm. Sys. For Traveler Info.	Collects and repackages information to make it useful to visitor
NPS – National Park Service	GGNRA Planning and Technical Assistance	Archived Data Management	Collect historical parking, traffic and weather data, work zone and special event activity
	GGNRA Planning and Technical Assistance	Archived Data User Systems	Uses data collected by GGNRA

Table 7-4: Description of Stakeholders, ITS Themes (cont.)

Stakeholder	Division	Entity	Description
NPS – National Park Service (cont.)	Western Resource Center	Archived Data User Systems	Uses data collected by GGNRA
	GGNRA Public Safety	Emergency Management	Park staff responsible for responding to emergencies
	GGNRA Public Safety	Emergency Vehicle	Park vehicles used in emergency response
	GGNRA Office of Special Park Uses	Event Promoters	Provide information on events and estimated traffic impacts
	GGNRA TBD	Information Service Provider	Collects and repackages information to make it useful to visitor
	GGNRA Maintenance and Engineering	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park
	GGNRA TBD	Other Parking	Represents GGNRA-owned parking facilities with which GGNRA may coordinate
	GGNRA Interpretation	Park Management	Collects visitation statistics (visitors, cars, tour buses, transit riders, bicyclists, pedestrians)
	GGNRA TBD	Parking Management	Tracks parking availability for all parking facilities related to GGNRA
	GGNRA TBD	Parking Operator	Human operator who tracks parking availability for the park
	GGNRA TBD	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)
	GGNRA TBD	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs
	GGNRA TBD	Traffic Management	Assesses current and future congestion on park roadways and determines traffic, parking, and emergency information to present to visitors
	GGNRA TBD	Traffic Operations Personnel	Human operator who interprets data processed by traffic management system
	GGNRA TBD	Transit Management	Manages and operates transit routes serving parking intercept lots
	GGNRA TBD	Transit Vehicle	Provides transit access to GGNRA park sites and intercept lot
	GGNRA TBD	Vehicle	Vehicle equipment of transit vehicle

Table 7-4: Description of Stakeholders, ITS Themes (cont.)

Stakeholder	Division	Entity	Description
Other	GPS Provider	Location Data Source	Provides geographic reference base
	Parking facility managers	Other Parking	Represents other parking facilities with which GGNRA may coordinate
	National Weather Service	Weather Service	Provide current and forecast weather conditions
Public	Visitors	Basic Vehicle	Receives information on parking availability and emergencies
	Visitors	Driver	Receives information on parking availability and emergencies
	Visitors	Event Promoters	Provide information on events, and estimated traffic reports
	Visitors	Personal Information Access	Provides pre-trip and transit information to visitors on their own device (personal digital assistant, cell phone, etc.)
	Facility managers (hotels, airport, GGNRA, etc.)	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)
	Kiosk/Terminal Owners For example, hotels and airports	Remote Traveler Support	Provides pre-trip traveler information at fixed locations (hotels, airports, etc.)
	Manager of Parking Intercept Lot	Remote Traveler Support	Provides information at transit stop of next scheduled transit arrival
	Visitors	Traffic	Represents vehicle traffic on roads accessing park sites
	Visitors	Transit User	Visitor parking a vehicle at a parking lot to transfer to transit
	Visitors	Vehicle	Vehicle in vicinity of park sites that may be affected by emergency response
	Visitors	Vehicle Characteristics	Vehicle count information for parking lot occupancy counts
SF - City/County of San Francisco	Public Works Department	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park
	Parking and Traffic, Department of	Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers

Table 7-4: Description of Stakeholders, ITS Themes (cont.)

Stakeholder	Division	Entity	Description
SF – City/County of San Francisco (cont)	Parking and Traffic, Department of	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs
SF MUNI - San Francisco MUNI	Transportation	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)
	Transportation	Transit Management	Manages and operates transit routes serving park sites, parking intercept lots, and other regional destinations
	Transportation	Transit Vehicle	Provides transit access to GGNRA park sites and intercept lot
	Transportation	Vehicle	Vehicle equipment of transit vehicle

Table 7-4: Description of Stakeholders, ITS Themes (cont.)

Entity Pair	Type of Relationship			
GGNRA Archived Data Management	 GGNRA provides archived data on request to 			
Caltrans D4 Archived Data User Systems	Caltrans District 4			
GGNRA Archived Data Management	Local road construction and management			
Caltrans District 4 / GGBHTD / Marin County / City and County of San Francisco Maintenance and Construction Management	agencies provide GGNRA with information regarding construction and work zone activities, to help the park predict future congestion			
GGNRA Archived Data Management	Regional traffic management centers provide			
Caltrans District 4 / Marin County / City and County of San Francisco Traffic Management	traffic data to GGNRA for archiving, to help the park predict future congestion			
GGNRA Archived Data Management	Transit agencies serving park sites provide data			
GG Transit / Marin County Transit / SF Muni Transit Management	for archiving by GGNRA, including schedule adherence and ridership statistics			
GGNRA Archived Data Management and Traffic Management	GGNRA receives and archives data on weather conditions at park sites			
Weather Service				
GGNRA Emergency Management	 GGNRA park police coordinate with local 			
Local Emergency Responders	emergency responders to respond to incidents, and facilitate evacuation of park facilities as needed			
GGNRA Emergency Management	GGNRA park police provide notification to local			
Local Public Safety Answering Points (PSAP)	PSAPs of major incidents			
GGNRA Traffic Management	GGNRA provides information to MTC 511 that can			
MTC-511 Information Service Provider	be put on 511 telephone or MTC web site			
GGNRA Traffic Management	 Road agencies provide real-time traffic information 			
Caltrans District 4 / GGBHTD / Marin County / City and County of San Francisco Roadway	 GGNRA GGNRA has ability to provide messages to be posted on local road agencies' CMS and HAR 			
GGNRA Traffic Management	 GGNRA may ask Caltrans to post messages on 			

Caltrans HAR or CMS

• Caltrans may provide GGNRA with traffic data for

archiving and use in forecasting congestion
GGNRA and Caltrans may share information on anticipated traffic impacts of special events

Table 7-5: Inter-agency Relationships with ITS Themes

Caltrans District 4 TMC

Traffic Management

8. IMPLEMENTATION PLAN

The implementation chapter discusses project sequencing, agency agreements, ITS standards, and maintaining the architecture.

8.1. Project Phasing

The National ITS Architecture is a useful tool for helping to phase deployment of ITS systems. This may be important from the perspectives both of obtaining project funding and securing institutional cooperation.

The three tiers of projects presented in this chapter provide a convenient framework to consider how integration and deployment of ITS may proceed over time. The CTMP projects, described in section 7.1, represent projects that are most likely to be implemented in the short-term (i.e. within the next two years). The early-winner candidate projects (described in section 7.2) represent other ideas that meet the park's immediate needs; however, the likelihood of implementation is less definite with exception of the portable changeable message signs which are being implemented as part of a pilot project in early 2005. Therefore, these projects are classified as medium-term, with implementation scheduled between three and five years. Section 7.3 reviewed ITS themes for GGNRA, which reflect a long-term view of with the park's direction for ITS implementation. These projects would be projected for implementation between six and ten years in the future.

In order to take advantage of this type of phased approach, it is helpful to examine the information flows between different organizations represented in the park-level architecture. This will facilitate design of systems that meet current and future needs, and will also help to establish working relationships between agencies that meet both short-term needs and long-term goals.

Diagrams showing the information flows to and from each entity included in the park-level architecture are provided in Appendix C. These diagrams have different colored lines to indicate which flows are short-term, medium-term and long-term.

8.2. List of Agency Agreements

It is intended that each multi-agency ITS deployment for GGNRA will include a Memorandum of Understanding (MOU) such as the one being drafted for the portable changeable message sign pilot project as shown in Appendix D.

8.3. Standards

One of the benefits of the National ITS Architecture is that it facilitates the utilization of standards. Standards can help to ensure seamless information-sharing between system components developed by different vendors, and between different regions' systems. Standards are being developed using a consensus-based approach through several standards development organizations, including the American Association of State Highway and Transportation

Officials (AASHTO), the American Society for Testing and Materials (ASTM), the Institute of Electrical and Electronics Engineers (IEEE), the International Organization of Standards (ISO), the Institute of Transportation Engineers (ITE), the National Electrical Manufacturers Association (NEMA), and the Society of Automotive Engineers (SAE).

Standards that may be applicable to GGNRA's park-level architecture, based on the information flows included in supporting the short-, medium- and long-term ITS projects for the park, are provided in Table 8-1. These standards may, in some cases, provide redundant capabilities, so care should be taken regarding which standards are selected for inclusion in various project specifications.

8.4. Maintaining the Architecture

Since an architecture is not a static document, it must be updated as new ITS projects arise. The intention of this document was to create an architecture for GGNRA with the intention that the next time the San Francisco Bay Area Regional architecture is updated, this plan will be incorporated into their architecture. With this knowledge, there is no plan to update or maintain this architecture draft other than providing it to MTC for inclusion with their architecture.

SDO	Document ID	Title	Туре
AASHTO/ITE/NEMA	NTCIP 1101	Simple Transportation Management Framework (STMF) ¹	Communication
	NTCIP 1102	Base Standard: Octet Encoding Rules ^{1, 2}	Communication
	NTCIP 1103	Simple Transportation Management Protocol (STMP) ¹	Communication
	NTCIP 1104	CORBA Naming Convention ²	Communication
	NTCIP 1105	CORBA Security Service ²	Communication
	NTCIP 1106	CORBA Near-Real Time Data Service ²	Communication
	NTCIP 1201	Global Object Definitions	Message
	NTCIP 1203	Object Definitions for Dynamic Message Signs	Message
	NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)	Message
	NTCIP 1206	Data Collection and Monitoring Devices	Message
	NTCIP 1208	Object Definitions for Video Switches	Message
	NTCIP 1209	Transportation System Sensor Objects	Message
	NTCIP 1401	TCIP – Common Public Transportation (CPT) Business Area Standard	Message
	NTCIP 1402	TCIP – Incident Management (IM) Business Area Standard	Message
NTCIP 1403		TCIP – Passenger Information (PI) Business Area Standard	Message
NTCIP 1404 NTCIP 1405 NTCIP 1406 NTCIP 1407		TCIP – Scheduling/Runcutting (SCH) Business Area Standard	Message
		TCIP – Spatial Representation (SP) Business Area Standard	Message
		TCIP – Onboard (OB) Business Area Standard	Message
		TCIP – Control Center (CC) Business Area Standard	Message
	NTCIP 1408	TCIP – Fare Collection (FC) Business Area Standard	Message
	NTCIP 2101	Point to Multi-Point Protocol Using RS-232 ¹	Communication
	NTCIP 2102	Subnet Profile for PMPP Over FSK modems ¹	Communication
	NTCIP 2103	Subnet Profile for Point-to-Point Protocol using RS 232 ¹	Communication
	NTCIP 2104	Subnet Profile for Ethernet ^{1, 2}	Communication
	NTICP 2201	Transportation Transport Profile ¹	Communication
	NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile ^{1, 2}	Communication
	NTCIP 2301	Application Profile for Simple Transportation Management Framework (STMF) ¹	Communication
	NTCIP 2302	Application Profile for Trivial File Transfer Protocol ¹	Communication
	NTCIP 2303	Application Profile for File Transfer Protocol (FTP) ^{1,2}	Communication
	NTCIP 2304	Application Profile for Data Exchange ASN.1 (DATEX) ²	Communication

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SDO	Document ID	Title	Туре	
AASHTO/ITE/NEMA	NTCIP 2305	Application Profile for Common Object Request Broker Architecture (CORBA) ²	Communication	
(cont.)	NTCIP 2501	Information Profile for DATEX ²	Communication	
	NTCIP 2502	Information Profile for CORBA ²	Communication	
ASTM	ASTM E2158-01	Standard Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz ³	Communication	
	ASTM E2259-xx	Standard Specification for Archiving ITS Generated Traffic Monitoring Data	Message	
	ASTM PS 105-99	Standard Provisional Specification for Dedicated Short Range Communication (DSRC) Data Link Layer ³	Communication	
IEEE	IEEE 802.2	Logical Link (Layer 2) for DSRC 5.9 GHz ⁵	Communication	
	IEEE 802.11	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications ⁵	Communication	
	IEEE Std 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications	Message	
	IEEE 1512-2000	2000 Standard for Common Incident Management Message Sets (IMMS) for use by EMCs ⁴		
	IEEE 1512.1-2003	Standard for Traffic Incident Management Message Sets for Use by EMCs ⁴	Message	
	IEEE P1512.2	Standard for Public Safety IMMS for use by EMCs ⁴	Message	
	IEEE 1512.3-2002	Standard for Hazardous Material IMMS for use by EMCs ⁴	Message	
	IEEE 1609.1	Resource Manager for DSRC 5.9 GHz ⁵	Communication	
	IEEE 1609.2	Application Services (Layers 6, 7) for DSCRB 5.9 GHz ⁵	Communication	
	IEEE 1609.3	Communications Services (Layers 4, 5) for DSRC 5.9 GHz (Future Standard) 5	Communication	
	IEEE 1609.4	Medium Access Control (MAC) Extension & the MAC Extension Management Entity for DSRC 5.9 $\rm GHz^5$	Communication	
ISO	ISO 21210	Networking Services (Layer 3) for DSRC 5.9 GHz ⁵	Communication	
ITE	ITE TM 1.03	Standard for Functional Level Traffic Management Data Dictionary (TMDD)	Data	
	ITE TM 2.01	Message Sets for External TMC Communication (MS/ETMCC)	Message	
SAE	SAE J2266	Location Referencing Message Specification (LRMS) ^{6, 7}	Message	
	SAE J2354	Message Set for Advanced Traveler Information System (ATIS) ^{6, 7}	Message	
	SAE J2369	Standard for ATIS Message Sets Delivered Over Bandwidth Restricted Media ⁶	Message	
	SAE J2529	Rules for Standardizing Street Names and Route IDs ^{6, 7}	Message	

Table 8-1: Applicable ITS Standards for GGNRA (cont.)							
SDO	Document ID	Title	Туре				
SAE (cont.)	SAE J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards ^{6, 7}	Message				
	SAE J2540-1	RDS (Radio Data System) Phrase List ^{6, 7}	Message				
	SAE J2540-2	ITIS (International Traveler Information Systems) Phrase Lists ^{6, 7}	Message				
	SAE J2540-3	National Names Phrase List ^{6, 7}	Message				
	SAE J2630	Converting ATIS Message Standards from ASN.1 to XML ^{6, 7}	Message				

¹ – Included in NTCIP Center-to-Field Standards Group
 ² – Included in NTCIP Center-to-Center Standards Group
 ³ – Included in Dedicated Short Range Communication at 915 MHz Standards Group
 ⁴ – Included in Incident Management Standards Group
 ⁵ – Included in Dedicated Short Range Communication at 5.9 GHz Standards Group
 ⁶ – Included in Advanced Traveler Information Systems (ATIS) Bandwidth Limited Standards Group
 ⁷ – Included in Advanced Traveler Information Systems (ATIS) General Use Standards Group

9. **REGIONAL INTEGRATION**

As mentioned earlier in this document, a San Francisco Bay Area Regional ITS Plan was created in June 2004 for the Metropolitan Transportation Commission. In order to maximize the benefits of ITS deployment to the park and its users, it is hoped that this GGNRA Architecture could be integrated and maintained with the Bay Area Regional ITS plan.

9.1. High-Level Architecture Diagrams

The relevant subsystems that were chosen for the GGNRA architecture are shown in Figure 9-1 and the relevant subsystems that were chosen for the Bay Area Regional architecture are shown in Figure 9-2. In both diagrams, the subsystems shown in grey are not relevant to that particular architecture.

The Bay Area Architecture includes more subsystems than the GGNRA architecture. The only subsystem that would need to be added to the Bay Area architecture if integrated with GGNRA's is the parking management subsystem.



Figure 9-1: GGNRA High-level Architecture Diagram



Figure 9-2: Bay Area High-Level Architecture Diagram

9.2. Bay Area Conceptual Implementation Diagram

The Bay Area conceptual implementation diagram, shown in Figure 9-3, was used as a highlevel representation of the architecture. If the GGNRA architecture were added to this architecture, the only addition to this diagram would be GGNRA's transportation management functions.



Figure 9-3: Bay Area Architecture Conceptual Implementation

10. SUMMARY AND NEXT STEPS

10.1. Summary

Transportation challenges affecting national parks must be innovative and context-sensitive in order to preserve the resources that national parks were created to protect. Intelligent transportation systems (ITS) may be one method for national parks to address some of these transportation challenges. Since ITS is most effective when deployed in an integrated fashion, it is important to have a guiding framework to ensure effective and efficient transfer of information between ITS deployments owned and operated by GGNRA with those operated by other agencies and organizations. The National and Regional ITS Architectures provide such a framework.

This document has applied the National ITS Architecture to a variety of ITS solutions proposed for Golden Gate National Recreation Area, including short-term projects identified through Marin Parklands transportation planning efforts like the CTMP (<u>13</u>), medium-term projects developed as candidate early-winner projects for the park (<u>12</u>), and long-term projects proposed as ITS themes for the park in Phase 1 of this project (<u>11</u>). This report also showed the points of intersection between the park's ITS architecture and the San Francisco Bay area's regional ITS architecture, in order to show where the park needs to work with other organizations and agencies to develop its ITS infrastructure.

The process used in this document may be applied to other national parks, once there is a good understanding of the park's transportation challenges and how park management would apply ITS solutions to meet park goals.

10.2. Next Steps

This document was written with several audiences in mind; accordingly, this section talks about next steps that are appropriate to each group.

10.2.1. Golden Gate National Recreation Area

The architecture presented in this document is a framework that can help to guide how GGNRA develops an ITS infrastructure to meet park management and visitor needs. It shows how project ideas that are anywhere from the concept to planning stage may be integrated to form a scaleable system. This document can provide an important step for helping GGNRA ITS projects to achieve conformity with the San Francisco Bay area's regional architecture, thereby complying with the National ITS Architecture.

This document, however, is not a strategic plan that defines specific projects for the future. The project concepts and priorities expressed here do not necessarily reflect a consensus agreement among park staff and/or other park stakeholders. If the park finds a need for a strategic plan, they should enter into a contract with a consultant to develop such a plan, or work with MTC for inclusion in the next Bay Area ITS plan. This document should serve as input into MTC's regional ITS plan.

Apart from a strategic plan, this document highlights the need for strategic partnerships between GGNRA and other agencies to help meet the transportation needs of park visitors. While technical solutions may be difficult, these partnerships and institutional arrangements are often more complicated and time-consuming. The park should seek to work with the stakeholders identified in this report, many of whom have participated in scoping meeting for this project, to lay the groundwork to develop partnerships that can support future ITS deployment.

10.2.2. Other Bay Area Agencies

This architecture highlights a variety of interconnections that the park would need to have with other stakeholders in order to implement the ITS projects presented in this report. While GGNRA has its own transportation needs, there is obvious interaction between regional challenges and park challenges. For example, traffic on roads accessing park sites can have spillover effects on Caltrans roadways, and vice-versa. Therefore, other Bay Area agencies are encouraged to review this architecture to look for opportunities to include GGNRA in future ITS initiatives. Potential opportunities include the following:

- inviting GGNRA as a steering committee member or stakeholder in a regional ITS planning or architecture process,
- looking for common system design interfaces into which GGNRA's needs could be easily included with marginal additional cost, and
- developing projects that could meet the needs of GGNRA and another agency, so that funding opportunities can be pooled and project benefits strengthened.

10.2.3. Other National Parks

The process in this document, described in more detail in the Phase 1 report (<u>11</u>), can be used as a model to help other national parks explore and implement ITS solutions to their transportation challenges. To obtain the most success, these parks should undertake the following steps:

- identify the park's transportation challenges in conjunction with other regional stakeholders as appropriate,
- work with Federal Highway Administration Federal Lands Highway Division staff to brainstorm potential ITS themes that could meet park challenges,
- prioritize ITS themes into short-, medium- and long-term projects,
- hire a contractor or consultant to help locate ITS themes within the National ITS Architecture, and select appropriate elements from the National ITS Architecture for inclusion in the park-level architecture,
- develop partnerships with other stakeholders as needed to support ITS themes, and
- finally, implement selected projects as funds are available.

10.3. Future Research

The Caltrans Division of Research and Innovation undertook this research effort to help national parks consider and implement ITS solutions to help address their transportation challenges, benefiting the parks, gateway communities, and the broader regional and state economies.

Architecture development is clearly an integral part of successful deployment of integrated ITS solutions. Through developing this report, several areas for future research were identified.

- <u>Case Studies of Integrating National Parks into Regional ITS Infrastructure</u>. GGNRA has been on the leading edge of seeking to work with regional stakeholders in addressing transportation challenges, as is demonstrated by transportation planning efforts in the Marin Parklands that involve coordination with other regional entities. The experiences of this park, along with others, could be documented to show how national parks can be successfully integrated into the region's ITS infrastructure. This could have significant economic benefits as tourists may be more likely to visit regional attractions in addition to their trip to the park.
- <u>Incorporating National Park Tourist Information onto 511 Traveler Information</u>. As 511 becomes increasingly common, it may be viewed as a potential resource to provide transportation information for tourists. Research into the most effective methods of presenting these different types of information to meet the needs of the different types of 511 users truckers, tourists and commuters would be valuable as national parks get increasingly interested in providing dynamic information to potential visitors.
- <u>National Park Extensions to National ITS Architecture</u>. The ITS themes developed in this
 research project required customization to address the specific needs of national parks.
 This customization indicated areas where the National ITS Architecture could need
 customization to better reflect national park needs. Research into reasonable extensions
 that could be made on the National ITS Architecture could help to standardize interfaces
 with national parks across the country, thus facilitating adoption of uniform
 communication and data protocols across NPS units. This research should include
 outreach to staff at park units, as well as regional service centers and NPS headquarters,
 to ensure that planning and data archiving needs are addressed.

APPENDIX A: DETAILED ARCHITECTURE FOR EARLY-WINNER PROJECTS

In section 7.2, Figure 7-2 showed how all of the early-winner projects interrelated into a system, and Table 7-2 listed all of the stakeholders which were involved in one or more early-winner projects. This appendix provides more detailed architectures for the early-winner projects. For each project, a diagram highlights which stakeholders are included, another diagram shows information flow between stakeholders, and a table describes these information flows.



Flow Name	Source		Dest	ination	Description	
driver information	С	Traffic Management	X	Driver	General advisory and traffic control information provided to the driver while en route.	
roadway information system data	C	Traffic Management	С	Roadway	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., changeable message signs). The flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these systems.	
roadway information system status	С	Roadway	С	Traffic Management	Current operating status of changeable message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.	
traffic information coordination	С	Traffic Management	Ν	Traffic Management	Traffic information exchanged between TMC's.	
	N	Traffic Management	С	Traffic Management	Normally would include incidents, congestion data, traffic data, signal timing plans, and real-time signal control information.	

Legend: **C** = Caltrans District 4; **N** = National Park Service; **X** = Public / Other

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Park-wide Radio System

Flow Name	Sou	rce	Dest	ination	Description
broadcast advisories	N	Roadway	X	Driver	General broadcast advisories that are provided over wide-area wireless communications direct to the vehicle radio. These analog advisory messages may provide similar content to ITS broadcast information flows, but include no digital data component. Existing Highway Advisory Radio (HAR) advisory messages are a prime example of this flow.
roadway information system data	N	Traffic Management	N	Roadway	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., dynamic message signs, highway advisory radio, beacon systems). This flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these systems.

Flow Name	Source		Destination		Description
roadway information system status	N	Roadway	N	Traffic Management	Current operating status of dynamic message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.

Legend: N = National Park Service; X = Public / Other

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Muir Woods/Stinson Beach Cameras



Flow Name		rce	Dest	tination	Description
traffic characteristics	x	Traffic	N	Roadway	Physical traffic characteristics which are monitored and translated into macroscopic measures like occupancy, volume, density, and average speed. Point measures support presence detection and individual vehicle measures like speed.
traffic images	X	Environment	Ν	Roadway	High fidelity, real-time traffic images suitable
	Ν	Roadway	Ν	Traffic Management	for surveillance monitoring by the operator or
	N	Traffic Management	N	Information Service Provider	flow includes the images and the operational status of the surveillance system.
video surveillance control	Ν	Traffic Management	N	Roadway	Information used to configure and control video surveillance systems.

Legend: **N** = National Park Service; **X** = Public / Other

NextBusTM/AVL for Muni and GGT



Flow Name		Source		nation	Description	
transit information user request	G, U	Transit Management	G, U	Remote Traveler Support	Request for special transit routing, real-time schedule information, and availability information.	
transit traveler information	G, U	Remote Traveler Support	G, U	Transit Management	Transit information prepared to support transit users and other travelers. It contains transit schedules, real-time arrival information, fare schedules, alerts and advisories, and general transit service information.	
transit vehicle location data	G, U	Transit Vehicle	G, U	Transit Management	Current transit vehicle location and related operational conditions data provided by a transit vehicle.	
traveler interface updates	G, U	Remote Traveler Support	X	Traveler	Visual or audio information (e.g., routes, messages, guidance, emergency information) that is provided to the traveler.	
vehicle location	G, U	Vehicle	G, U	Transit Vehicle	Location of a vehicle calculated on-board the vehicle.	

Legend: G = Golden Gate Bridge, Highway and Transportation District, U = San Francisco MUNI; X = Public / Other

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Reservation System for Parking at Muir Woods and Stinson Beach

Flow Name	Source		Destination		Description
parking demand management request	N	Traffic Management	N	Parking Management	Request to change the demand for parking facility use through pricing or other mechanisms.

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Flow Name	Source		Des	tination	Description
parking demand management response	N	Parking Management	N	Traffic Management	Response to parking demand management change requests indicating level of compliance with request.
parking information	N	Parking Management	Ν	Traffic Management	General parking information and current parking availability.
parking lot data request	Ν	Traffic Management	Ν	Parking Management	Request for parking lot occupancy, fares, and availability. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
payment	X	Traveler Card	X	Personal Information Access	Payment of some kind (e.g., toll, parking, fare) by traveler which, in most cases, can be
	X	Traveler Card	X	Remote Traveler Support	related to a credit account.
payment request	N	Information Service Provider	X	Financial Institution	Request for payment from financial institution.
request for payment	X	Personal Information Access	X	Traveler Card	Request to deduct cost of service from user's payment account.
	X	Remote Traveler Support	X	Traveler Card	
request tag data	N	Parking Management	X	Vehicle	Request for tag information including credit identity, stored value card cash, etc.
tag data	Х	Vehicle	Ν	Parking Management	Unique tag ID and related vehicle information.
traffic operator data	N	Traffic Management	N	Traffic Operations Personnel	Presentation of traffic operations data to the operator including traffic conditions, current operating status of field equipment, maintenance activity status, incident status, video images, security alerts, emergency response plan updates and other information. This data keeps the operator appraised of current road network status, provides feedback to the operator as traffic control actions are implemented and supports review of historical data and preparation for future traffic operations activities.

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Flow Name traffic operator inputs	Source		Destination		Description
	N	Traffic Operations Personnel	N	Traffic Management	Traffic operations requests for information, configuration changes, commands to adjust current traffic control strategies (e.g., adjust signal timing plans, change DMS messages), and other traffic operations data entry.
transaction status	X	Financial Institution	N	Information Service Provider	Response to transaction request. Normally dealing with a request for payment.
traveler inputs	X	Traveler	X	Personal Information Access	Request by a traveler to summon assistance, request travel information, make a reservation, or request any other traveler service.
	X	Traveler	X	Remote Traveler Support	
traveler interface updates	X	Personal Information Access	X	Traveler	Visual or audio information (e.g., routes, messages, guidance, emergency information) that is provided to the traveler.
	X	Remote Traveler Support	X	Traveler	
yellow pages information	Ν	Information Service Provider	X	Personal Information Access	Travel service information covering tourist attractions, lodging, restaurants, service
	Ν	Information Service Provider	X	Remote Traveler Support	stations, emergency services, and other services and businesses of interest to the traveler.
yellow pages request	X	Personal Information Access	N	Information Service Provider	Request for information through a yellow pages type service.
	x	Remote Traveler Support	Ν	Information Service Provider	

Legend: N = National Park Service; X = Public / Other



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Flow Name	Source		Dest	tination	Description
broadcast information	N	Information Service Provider	X	Personal Information Access	General broadcast information that contains link travel times, incidents, advisories, transit
	N	Information Service Provider	x	Remote Traveler Support	services and a myriad of other traveler information.
ISP coordination	С	Information Service Provider	N	Information Service Provider	Coordination and exchange of transportation information between centers. This flow allows a
	N	Information Service Provider	С	Information Service Provider	broad range of transportation information collected by one ISP to be redistributed to many other ISPs and their clients.
parking information	Ν	Parking Management	Ν	Traffic Management	General parking information and current parking availability.
parking lot data request	N	Traffic Management	N	Parking Management	Request for parking lot occupancy, fares, and availability. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
road network conditions	С	Traffic Management	0	Information Service Provider	Current and forecasted traffic information, road and weather conditions, traffic incident
	N	Traffic Management	0	Information Service Provider	information, and other road network status. Either raw data, processed data, or some
	N	Traffic Management	N	Information Service Provider	Combination of both may be provided by this architecture flow. Information on diversions and alternate routes, closures, and special traffic restrictions (lane/shoulder use, weight restrictions, width restrictions, HOV requirements) in effect is also included.
traffic information coordination	С	Traffic Management	Ν	Traffic Management	Traffic information exchanged between TMC's.
	N	Traffic Management	С	Traffic Management	Normally would include incidents, congestion data, traffic data, signal timing plans, and real- time signal control information.
transit and fare schedules	G, U	Transit Management	N	Information Service Provider	Transit service information including routes, schedules, schedule adherence, and fare information. Includes transit service information during evacuation.

Flow Name	Sou	irce	Desti	ination	Description
transit information request	N	Information Service Provider	G, U	Transit Management	Request for transit operations information including schedule and fare information. The request can be a subscription that initiates as- needed information updates as well as a one- time request for information.
traveler information	N	Information Service Provider	X	Personal Information Access	Traveler information comprised of traffic and road conditions, advisories, incidents, payment
	Ν	Information Service Provider	X	Remote Traveler Support	information, transit services, and many other travel-related data updates and confirmations.
traveler inputs	X	Traveler	X	Personal Information Access	Request by a traveler to summon assistance, request travel information, make a reservation,
2	X	Traveler	X	Remote Traveler Support	or request any other traveler service.
traveler interface updates	X	Personal Information Access	X	Traveler	Visual or audio information (e.g., routes, messages, guidance, emergency information) that is provided to the traveler.
	X	Remote Traveler Support	X	Traveler	
traveler request	X	Personal Information Access	Ν	Information Service Provider	Request by a traveler to summon assistance, request information, make a reservation, or
-	X	Remote Traveler Support	N	Information Service Provider	initiate any other traveler service.
voice-based traveler information	0	Information Service Provider	0	Telecommunications System for Traveler Information	Traveler information sent to the telecommunications systems for traveler information terminator. This flow may represent the bulk transfer of traveler information, including traffic conditions, incident information transit information and weather and road condition information. It may be specially formatted for voice-based traveler information.

Flow Name	Source		Dest	ination	Description
voice-based traveler request	0	Telecommunications System for Traveler Information	0	Information Service Provider	The electronic traveler information request from the telecommunications systems for traveler information terminator. It may be specifically formatted for voice-based traveler requests. The request can be a general subscription intended to initiate a continuous o regular data stream or a specific request intended to initiate a one-time response from the recipient.
weather information	X	Weather Service	N	Information Service Provider	Accumulated forecasted and current weather data (e.g., temperature, pressure, wind speed, wind direction, humidity, precipitation, visibility, light conditions, etc.).

Legend: C = Caltrans District 4; G = Golden Gate Bridge, Highway and Transportation District; N = National Park Service; O = Metropolitan Transportation Commission's 511 System; U = San Francisco MUNI; X = Public / Other



Flow Name Source Destination Description Ν Archived Data Ν Traffic Management A request to a data source for information on archive requests Management available data (i.e. "catalog") or a request that defines the data to be archived. The request can be a general subscription intended to initiate a continuous or regular data stream or a specific request intended to initiate a onetime response from the recipient. Ν Traffic Management Х Plans for major events possibly impacting **Event Promoters** event plans traffic.

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Flow Name	Sourc	e .	Desti	nation	Description
traffic information coordination	С	Traffic Management	Ν	Traffic Management	Traffic information exchanged between TMC's.
	N	Traffic Management	С	Traffic Management	Normally would include incidents, congestion data, traffic data, signal timing plans, and real-time signal control information.
traffic operator data	N	Traffic Management	N	Traffic Operations Personnel	Presentation of traffic operations data to the operator including traffic conditions, current operating status of field equipment, maintenance activity status, incident status, video images, security alerts, emergency response plan updates and other information. This data keeps the operator appraised of current road network status, provides feedback to the operator as traffic control actions are implemented and supports review of historical data and preparation for future traffic operations activities.
traffic operator inputs	N	Traffic Operations Personnel	N	Traffic Management	Traffic operations requests for information, configuration changes, commands to adjust current traffic control strategies (e.g., adjust signal timing plans, change DMS messages), and other traffic operations data entry.

Legend: C = Caltrans District 4; N = National Park Service; X = Public / Other



Destination

Roadway

Public

Pedestrians

Ν

Х

Х

Description
Request for pedestrian crossing.
Signal to pedestrians indicating permission to cross roadway.
General advisory and traffic control information provided to the driver while en route.

Legend: NPS = National Park Service; X = Public / Other

Source

Pedestrians

Roadway

Roadway

Х

Ν

Ν

Flow Name

crossing call

crossing permission

driver information

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APPENDIX B: DETAILED ARCHITECTURE FOR ITS THEMES

In section 7.3, Figure 7-3 showed how all of the ITS themes interrelated into a system, and Table 7-4 listed all of the stakeholders involved in one or more ITS themes. This appendix provides more detailed architectures for the ITS themes. For each theme, a diagram highlights the stakeholders included, a diagram shows information flows between stakeholders, and a table describes these information flows.



Flow Name		Source		nation	Description
archive requests	N Archived Data C, G, M, M, N, S Management M, N, S N T X M	Archived Data Management	C, G, M, N, S	Maintenance and Construction Management	A request to a data source for information on available data (i.e. "catalog") or a request that defines the data to be archived. The request
			Ν	Traffic Management	can be a general subscription intended to
		Weather Service	a specific request intended to initiate a one- time response from the recipient.		

Flow Name archive status	Source		Desti	nation	Description
	N	Archived Data Management	C, G, M, N, S N X	Maintenance and Construction Management Traffic Management Weather Service	Notification that data provided to an archive contains erroneous, missing, or suspicious data or verification that the data provided appears valid. If an error has been detected, the offending data and the nature of the potential problem are identified.
event plans	N, X	Event Promoters	N	Traffic Management	Plans for major events possibly impacting traffic.
maint and constr archive data	C, G, M, N, S	Maintenance and Construction Management	N	Archived Data Management	Information describing road construction and maintenance activities identifying the type of activity, the work performed, and work zone information including work zone configuration and safety (e.g., a record of intrusions and vehicle speeds) information. For construction activities, this information also includes a description of the completed infrastructure, including as-built plans as applicable. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
traffic archive data	N	Traffic Management	N	Archived Data Management	Information describing the use and vehicle composition on transportation facilities and the traffic control strategies employed. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
traffic characteristics	X	Traffic	C, G, M, N, S	Roadway	Physical traffic characteristics which are monitored and translated into macroscopic measures like occupancy, volume, density, and average speed. Point measures support presence detection and individual vehicle measures like speed.

Flow Name	Sourc	e	Desti	nation	Description
traffic information coordination	C, S	Other TM	Ν	Traffic Management	Traffic information exchanged between TMC's
	N	Traffic Management	C, S	Other TM	Normally would include incidents, congestion data, traffic data, signal timing plans, and real-time signal control information.
traffic operator data	N	Traffic Management	N	Traffic Operations Personnel	Presentation of traffic operations data to the operator including traffic conditions, current operating status of traffic control equipment, maintenance activity status, incident status, and other information. This data keeps the operator appraised of current road network status, provides feedback to the operator as traffic control actions are implemented, and supports review of historical data and preparation for future traffic operations activities.
traffic operator inputs	N	Traffic Operations Personnel	N	Traffic Management	Traffic operations requests for information, configuration changes, commands to adjust current traffic control strategies (e.g., adjust signal timing plans, change DMS messages), and other traffic operations data entry.
weather information	X	Weather Service	N	Archived Data Management	Accumulated forecasted and current weather data (e.g., temperature, pressure, wind speed,
	X	Weather Service	Ν	Traffic Management	wind direction, humidity, precipitation, visibility, light conditions, etc.).
work zone information	C, G, M, N, S	Maintenance and Construction Management	N	Traffic Management	Summary of maintenance and construction work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

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Legend: **C** = Caltrans; **G** = Golden Gate Bridge, Highway and Transportation District; **M** = Marin County; **N** = National Park Service; **S** = City and County of San Francisco; **X** = Public / Other

Data Collection and Storage NPS СТ NPS MC SF CT Archived Data User archived data product Systems Roadway requests archive archive analysis analysis roadside requests results archive archive - request -confirmation data archived data products NPS NPS MUNI MCT NPS MC CT SF traffic archive data archive status Transit Archived Data Traffic archive requests archive requests Management Management Management transit archive data archive status visitation archive archive archive requests status data NPS Park Management

Flow Name	Source		Dest	ination	Description
archive analysis requests	C, N	Archived Data User Systems	Ν	Archived Data Management	A user request that initiates data mining, analytical processing, aggregation or summarization, report formulation, or other advanced processing and analysis of archived data. The request also includes information that is used to identify and authenticate the user and support electronic payment requirements, if any.

Flow Name	Sour	ce	Desti	nation	Description
archive analysis results	N	Archived Data Management	C, N	Archived Data User Systems	Processed information products, supporting meta data, and any associated transaction information resulting from data mining, analytical processing, aggregation or summarization, report formulation, or other on- line processing and analysis of archived data.
archive request confirmation	Ν	Archived Data Management	C, N	Archived Data User Systems	Confirmation that an archive request has been received and processed with information on the disposition of the request.
archived data product requests	C, N	Archived Data User Systems	N	Archived Data Management	A user-specified request for archived data products (i.e. data, meta data, or data catalogs). The request also includes information that is used to identify and authenticate the user and support electronic payment requirements, if any.
archived data products	N	Archived Data Management	C, N	Archived Data User Systems	Raw or processed data, meta data, data catalogs and other data products provided to a user system upon request. The response may also include any associated transaction information.
archive requests	Ν	Archived Data	Ν	Park Management	A request to a data source for information on
		Management	C, M, N, S	Traffic Management	available data (i.e. "catalog") or a request that defines the data to be archived. The request
			G, N, T, U	Transit Management	initiate a continuous or regular data stream o a specific request intended to initiate a one- time response from the recipient.
archive status	Ν	Archived Data	Ν	Park Management	Notification that data provided to an archive
		Management	C, M, N, S	Traffic Management	contains erroneous, missing, or suspicious data or verification that the data provided
			G, N, T, U	Transit Management	the offending data and the nature of the potential problem are identified.

Flow Name	Sourc	e	Dest	tination	Description
roadside archive data	C, G, M, N, S	Roadway	N	Archived Data Management	A broad set of data derived from roadside sensors that includes current traffic conditions, environmental conditions, and any other data that can be directly collected by roadside sensors. This data also indicates the status of the sensors and reports of any identified sensor faults.
traffic archive data	C, M, N, S	Traffic Management	N	Archived Data Management	Information describing the use and vehicle composition on transportation facilities and the traffic control strategies employed. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
transit archive data	G, N, T, U	Transit Management	N	Archived Data Management	Data used to describe and monitor transit demand, fares, operations, and system performance. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
visitation archive data	N	Park Management	N	Archived Data Management	Information related to park visitors, including the number of visitors, aggregate statistics of modal choice (car, tour bus, bicycle, pedestrian, public transit, etc.), statistics related to overnight usage of park facilities and other information that may be useful for real- time or planning purposes.

Legend: C = Caltrans; G = Golden Gate Bridge, Highway and Transportation District; M = Marin County; N = National Park Service; S = City and County of San Francisco; T = Marin County Transit; U = San Francisco MUNI

Parking Management and Information NPS Public Public Parking Operator **Basic Vehicle** Driver parking request for parking broadcast driver operator performance status advisories information inputs data NPS parking NPS NPS MC СТ Other Parking coordination Parking Roadway Public Management vehicle Vehicle characteristics Characteristics roadway roadway parking parking archive information archive archive availability information status requests system system data status data NPS NPS archive requests Archived Data Traffic -traffic archive data -Weather Service weather Management Management information archive requests

Flow Name	Sou	Source		tination	Description
archive requests	N	Archived Data Management	N N X	Parking Management Traffic Management Weather Service	A request to a data source for information on available data (i.e. "catalog") or a request that defines the data to be archived. The request can be a general subscription intended to initiate a continuous or regular data stream or a specific request intended to initiate a one-
					a specific request intended to initiate a o time response from the recipient.



Flow Name	Source		Des	tination	Description
archive status	N	Archived Data Management	N	Parking Management	Notification that data provided to an archive contains erroneous, missing, or suspicious data or verification that the data provided appears valid. If an error has been detected, the offending data and the nature of the potential problem are identified.
broadcast advisories	C, M, N	Roadway	X	Basic Vehicle	General broadcast advisories that are provided over wide-area wireless communications direct to the vehicle radio. These analog advisory messages may provide similar content to ITS broadcast information flows, but include no digital data component. Existing Highway Advisory Radio (HAR) advisory messages are a prime example of this flow.
driver information	С, М, N	Roadway	X	Driver	General advisory and traffic control information provided to the driver while en route.
parking archive data	N	Parking Management	N	Archived Data Management	Data used to analyze and monitor trends in parking demand, pricing, and operational actions. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
parking availability	Ν	Parking Management	Ν	Traffic Management	Current parking lot occupancy, parking availability, and cost information.
parking coordination	Ν	Other Parking	Ν	Parking Management	Information that enables parking management
	Ν	Parking Management	Ν	Other Parking	activities to be coordinated between different parking operators or systems in a region.
parking operator inputs	Ν	Parking Operator	Ν	Parking Management	Local parking operator inputs that query current status and control the operation of the parking management system.
parking status	Ν	Parking Management	Ν	Parking Operator	Parking lot operational status.
request for performance data	Ν	Parking Operator	Ν	Parking Management	Request issued by a service provider for current parking service performance data.

Flow Name	Sourc	e	Desti	nation	Description
roadway information system data	N	Traffic Management	C, M, N	Roadway	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., changeable message signs, highway advisory radio, beacon systems). The flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these
roadway information system status	С, М, N	Roadway	N	Traffic Management	Current operating status of changeable message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.
traffic archive data	N	Traffic Management	N	Archived Data Management	Information describing the use and vehicle composition on transportation facilities and the traffic control strategies employed. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
vehicle characteristics	X	Vehicle Characteristics	N	Parking Management	The physical or visible characteristics of an individual vehicle that can be measured to classify a vehicle and imaged to uniquely identify a vehicle.
weather information	x	Weather Service	N	Archived Data Management	Accumulated forecasted and current weather data (e.g., temperature, pressure, wind speed, wind direction, humidity, precipitation, visibility, light conditions, etc.).

Legend: C = Caltrans; M = Marin County; N = National Park Service; X = Public / Other

Parking Intercept





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Flow Name	Sourc	e	Desti	nation	Description
broadcast advisories	C, M, N	Roadway	X	Basic Vehicle	General broadcast advisories that are provided over wide-area wireless communications direct to the vehicle radio. These analog advisory messages may provide similar content to ITS broadcast information flows, but include no digital data component. Existing Highway Advisory Radio (HAR) advisory messages are a prime example of this flow.
driver information	C, M, N	Roadway	X	Driver	General advisory and traffic control information provided to the driver while en route.
mode change	X	Driver	X	Transit User	Visitor response to change from driving access to transit access.
parking availability	N	Parking Management	Ν	Traffic Management	Current parking lot occupancy, parking availability, and cost information.
parking coordination	Ν	Other Parking	Ν	Parking Management	Information that enables parking management
	Ν	Parking Management	N	Other Parking	activities to be coordinated between different parking operators or systems in a region.
position fix	X	Location Data Source	G, N, T, U	Vehicle	Information which provides a traveler's or vehicle's geographical position.
roadway information system data	N	Traffic Management	C, M, N	Roadway	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., changeable message signs, highway advisory radio, beacon systems). The flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these systems.
roadway information system status	С, М, N	Roadway	N	Traffic Management	Current operating status of changeable message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.

Flow Name	Sourc	e	Desti	nation	Description
transit information user request	G, N, T, U	Remote Traveler Support	G, N, T, U	Transit Management	Request for special transit routing, real-time schedule information, and availability information.
transit traveler information	G, N, T, U	Transit Management	G, N, T, U	Remote Traveler Support	Transit information prepared to support transit users and other travelers. It contains transit schedules, real-time arrival information, fare schedules, and general transit service information.
transit user inputs	X	Transit User	N	Remote Traveler Support	Requests from transit user through either an on-board or fixed location traveler information station.
transit user outputs	N	Remote Traveler Support	X	Transit User	Information for traveler from either an on- board or fixed location traveler information station.
transit vehicle location data	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Current transit vehicle location and related operational conditions data provided by a transit vehicle.
transit vehicle schedule performance	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Estimated times of arrival and anticipated schedule deviations reported by a transit vehicle.
vehicle characteristics	x	Vehicle Characteristics	N	Parking Management	The physical or visible characteristics of an individual vehicle that can be measured to classify a vehicle and imaged to uniquely identify a vehicle.
vehicle location	G, N, T, U	Vehicle	G, N, T, U	Transit Vehicle	Location of vehicle and other vehicle characteristics which are exchanged between vehicle subsystems.

Legend: C = Caltrans; G = Golden Gate Bridge, Highway and Transportation District; M = Marin County; N = National Park Service; T = Marin County Transit; U = San Francisco MUNI; X = Public / Other

Pre-Trip Traveler Information NPS NPS СТ MC Parking СТ NC 17 Roadway Management Other TM Weather Service traffic information traffic coordination parking images parking traffic NPS Public lot data information flow weather request and an Inste NPS Public information note Tre Bupport **Remote Traveler** Support Event Promoters NPS NPS -traveler information traveler requestrequest for road network conditions Information Traffic event plans -Service Provider road network Management Public -traveler information conditions -traveler request-Personal NPS CT MC SF Information Maintenance and transit transit Access and fare information -maint and constr work plans Construction request schedules Management NPS MCT NPS MUNI MCT transit vehicle location data Transit **Transit Vehicle** transit vehicle Management schedule performance vehicle position location fix Location Data Source VPS I MCT Vehicle

Flow Name	Source		Destination		Description
event plans	N, X	Event Promoters	Ν	Traffic Management	Plans for major events possibly impacting traffic.

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Flow Name	Sourc	e	Desti	nation	Description
maint and constr work plans	C, G, M, N, S	Maintenance and Construction Management	N, O	Information Service Provider	Future construction and maintenance work schedules and activities including anticipated closures with anticipated impact to the roadway, alternate routes, anticipated delays, closure times, and durations.
parking information	Ν	Parking Management	Ν, Ο	Information Service Provider	General parking information and current parking availability.
parking lot data request	N, O	Information Service Provider	N	Parking Management	Request for parking lot occupancy, fares, and availability. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
position fix	X	Location Data Source	G, N, T, U	Vehicle	Information which provides a traveler's or vehicle's geographical position.
request for road network conditions	N, O	Information Service Provider	N	Traffic Management	Request for traffic information, road conditions, surface weather conditions, incident information, and other road network status. The request specifies the region/route of interest, the desired effective time period, and other parameters that allow preparation of a tailored response. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
road network conditions	N	Traffic Management	N, O	Information Service Provider	Current and forecasted traffic information, road and weather conditions, incident information, and other road network status. Either raw data, processed data, or some combination of both may be provided by this architecture flow.
traffic flow	С, М, N	Roadway	N	Traffic Management	Raw and/or processed traffic detector data which allows derivation of traffic flow variables (e.g., speed, volume, and density measures) and associated information (e.g., congestion, potential incidents).

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Flow Name	Sourc	e	Desti	nation	Description
traffic images	C, M, N	Roadway	N, O	Information Service Provider	High fidelity, real-time traffic images suitable for surveillance monitoring by the operator or for use in machine vision applications. This flow includes the images and the operational status of the surveillance system.
traffic information coordination	C, S	Other TM	Ν	Traffic Management	Traffic information exchanged between TMC's.
	N	Traffic Management	C, S	Other TM	Normally would include incidents, congestion data, traffic data, signal timing plans, and real- time signal control information.
transit and fare schedules	G, N, T, U	Transit Management	N, O	Information Service Provider	Specific transit and fare schedule information including schedule adherence.
transit information request	N, O	Information Service Provider	G, N, T, U	Transit Management	Request for transit operations information including schedule and fare information. The request can be a subscription that initiates as- needed information updates as well as a one- time request for information.
transit vehicle location data	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Current transit vehicle location and related operational conditions data provided by a transit vehicle.
transit vehicle schedule performance	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Estimated times of arrival and anticipated schedule deviations reported by a transit vehicle.
traveler information	N, O	Information Service Provider	N	Personal Information Access	Traveler information comprised of traffic status, advisories, incidents, payment
	N, O	Information Service Provider	N, X	Remote Traveler Support	information and many other travel-related data updates and confirmations.
traveler request	N	Personal Information Access	N, O	Information Service Provider	Request by a traveler to summon assistance, request information, make a reservation, or
	Ν, Χ	Remote Traveler Support	Ν, Ο	Information Service Provider	initiate any other traveler service.
vehicle location	G, N, T, U	Vehicle	G, N, T, U	Transit Vehicle	Location of vehicle and other vehicle characteristics which are exchanged between vehicle subsystems.

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Flow Name	Source		Destination		Description
weather information	X	Weather Service	N, O	Information Service Provider	Accumulated forecasted and current weather data (e.g., temperature, pressure, wind speed, wind direction, humidity, precipitation, visibility, light conditions, etc.).

Legend: **C** = Caltrans; **G** = Golden Gate Bridge, Highway and Transportation District; **M** = Marin County; **N** = National Park Service; **O** = Metropolitan Transportation Commission; **S** = City and County of San Francisco; **T** = Marin County Transit; **U** = San Francisco MUNI; **X** = Public / Other



Flow Name	Source		Destination		Description
position fix	X	Location Data Source	G, N, T, U	Vehicle	Information which provides a traveler's or vehicle's geographical position.
transit and fare schedules	G, N, T, U	Transit Management	N, O	Information Service Provider	Specific transit and fare schedule information including schedule adherence.

Flow Name	Sourc	ce	Desti	nation	Description
transit information request	N, O	Information Service Provider	G, N, T, U	Transit Management	Request for transit operations information including schedule and fare information. The request can be a subscription that initiates as- needed information updates as well as a one- time request for information.
transit vehicle location data	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Current transit vehicle location and related operational conditions data provided by a transit vehicle.
transit vehicle schedule performance	G, N, T, U	Transit Vehicle	G, N, T, U	Transit Management	Estimated times of arrival and anticipated schedule deviations reported by a transit vehicle.
traveler information	N, O	Information Service Provider	Ν	Personal Information Access	Traveler information comprised of traffic status, advisories, incidents, payment
	Ν, Ο	Information Service Provider	Ν, Χ	Remote Traveler Support	information and many other travel-related data updates and confirmations.
traveler request	N	Personal Information Access	Ν, Ο	Information Service Provider	Request by a traveler to summon assistance, request information, make a reservation, or
Ν,	Ν, Χ	Remote Traveler Support	Ν, Ο	Information Service Provider	initiate any other traveler service.
vehicle location	G, N, T, U	Vehicle	G, N, T, U	Transit Vehicle	Location of vehicle and other vehicle characteristics which are exchanged between vehicle subsystems.

Legend: C = Caltrans; G = Golden Gate Bridge, Highway and Transportation District; M = Marin County; N = National Park Service; O = Metropolitan Transportation Commission; S = City and County of San Francisco; T = Marin County Transit; U = San Francisco MUNI; X = Public / Other

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r	T				
Flow Name	Sourc	e .	Desti	nation	Description
broadcast advisories	C, M, N	Roadway	X	Basic Vehicle	General broadcast advisories that are provided over wide-area wireless communications direct to the vehicle radio. These analog advisory messages may provide similar content to ITS broadcast information flows, but include no digital data component. Existing Highway Advisory Radio (HAR) advisory messages are a prime example of this flow.
broadcast information	N, O	Information Service Provider	x	Personal Information Access	General broadcast information that contains link travel times, incidents, advisories, transit
	N, O	Information Service Provider	Ν, Χ	Remote Traveler Support	services and a myriad of other traveler information.
	Ν, Ο	Information Service Provider	x	Vehicle	
driver information	С, М, N	Roadway	x	Driver	General advisory and traffic control information provided to the driver while en route.
emergency dispatch requests	N	Emergency Management	N	Emergency Vehicle	Emergency vehicle dispatch instructions including incident location and available information concerning the incident.
incident command information	N	Emergency Management	N	Emergency Vehicle	Information that supports local management of an incident. It includes resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response.
incident command request	N	Emergency Vehicle	Ν	Emergency Management	Request for resources, commands for relay to other allied response agencies, and other requests that reflect local command of an evolving incident response.

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Flow Name	Source		Desti	nation	Description
incident information	N	Emergency Management	N, O	Information Service Provider	Notification of existence of incident and expected severity, location, time and nature of
	N	Emergency Management	C, M, N, S	Traffic Management	incident.
	C, M, N, S	Traffic Management	N	Emergency Management	
incident notification	X	Emergency Telecommunications System	Ν	Emergency Management	The notification of an incident including its nature, severity, and location.
incident notification response	N	Emergency Management	X	Emergency Telecommunications System	Interactive acknowledgement and verification of the incident information received, requests for additional information, and general information on incident response status.
incident report	Ν	Emergency Management	X	Other EM	Report of an identified incident including incident location, type, severity and other
	X	Other EM	Ν	Emergency Management	information necessary to initiate an appropriate incident response.
incident response coordination	Ν	Emergency Management	X	Other EM	Incident response procedures, resource coordination, and current incident response
	X	Other EM	N	Emergency Management	status that are shared between allied response agencies to support a coordinated response to incidents. The flow also coordinates a positive hand off of responsibility for all or part of an incident response between agencies.
incident status	N	Emergency Vehicle	N	Emergency Management	Information gathered at the incident site that more completely characterizes the incident and provides current incident response status.
resource deployment status	C, M, N, S	Traffic Management	N	Emergency Management	Status of traffic management center resource deployment identifying the resources available and their current deployment status.
resource request	N	Emergency Management	C, M, N, S	Traffic Management	A request for traffic management resources to implement special traffic control measures, assist in clean up, verify an incident, etc.

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Flow Name	Source		Desti	nation	Description
roadway information system data	N	Traffic Management	C, M, N	Roadway	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., changeable message signs, highway advisory radio, beacon systems). The flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these systems.
roadway information system status	С, М, N	Roadway	N	Traffic Management	Current operating status of changeable message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.

Legend: C = Caltrans; M = Marin County; N = National Park Service; O = Metropolitan Transportation Commission; S = City and County of San Francisco; X = Public / Other

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APPENDIX C: ENTITY-LEVEL ARCHITECTURE FLOW DIAGRAMS

This section includes architecture flow diagrams for each of the entities included in the parklevel architecture. This helps to show how information will need to flow between various entities in the short-, medium- and long-terms, facilitating system design and institutional cooperation.

Because the focus of this architecture is on GGNRA, non-park entities are often grouped together. Moreover, architecture flows for non-park entities are included only to the extent they relate to the park's ITS goals as outlined in this report. More detailed representations of their flows may be available in the San Francisco Regional ITS Architecture, available at http://www.iteris.com/mtcits/preview/index.html.

Many entities are represented in more than one figure, to reflect the diversity of functions encompassed within that one unit. In some cases, a figure will represent more than one entity, in order to demonstrate how entities may seek to adopt a common method of sharing information.

The table starting on the next page shows the entities which are included in this appendix. The page number in bold indicates that the figure on that page shows all flows involving that entity.

Legend:

traffic flow►	Existing / Outside of Park-level Architecture
	Short-Term (CTMP)
driver information>	Medium-Term (Early Winner Projects)
archive requests	Long-Term (Phase 1 Report)
mode change	Non-Architecture Flow

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Entity	Division	Label	Description	Page
CT - Caltrans District 4	Highway Operations / Maintenance	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park	106, 109, 120, 127, 129
	Highway Operations / TMC	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs	98, 99, 100, 106, 120, 133, 141
		Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers	98, 100, 101, 106, 107, 120, 127
		Traffic Operations Personnel	Human operator who interprets data processed by traffic management system	100, 101
	Transportation Planning	Archived Data User Systems	Uses data collected by GGNRA	102 , 106
ER – Emergency Response	Local PSAP	Emergency Telecommunications System	911 or other service that provides information about emergencies	107, 124
	California Highway Patrol San Francisco or Marin	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites	123
	City/County of San Francisco Police Department and Sheriff's Department	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites	123
	Local Law Enforcement	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites	107, 123
	Marin County Sheriff's Office	Other EM	Other regional agencies responsible for emergency response in vicinity of park sites	123
GGT - Golden Gate Bridge, Highway and Transportation District	Golden Gate Bridge	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park	106, 109, 120, 127, 129

Entity	Division	Label	Description	Page
Golden Gate Bridge, Highway and Transportation District (cont)	Golden Gate Bridge	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs	106, 120, 122 , 141
	Golden Gate Transit	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)	131, 142
	Golden Gate Transit	Transit Management	Manages and operates transit routes serving park sites, parking lots, and other regional destinations	106, 109, 114, 127, 131
	Golden Gate Transit	Transit Vehicle	Provides transit access to GGNRA park sites and parking lots	131
	Golden Gate Transit	Vehicle	Vehicle equipment of transit vehicle	131
MC – Marin County	Department of Public Works / Roads	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park	106, 109, 120, 127, 129
	Department of Public Works / Traffic	Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers	106, 107, 126
	Department of Public Works / Traffic (Office of Emergency Services for HAR)	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs	99 , 106, 120, 125 , 132, 141
MCT – Marin County Transit	Board of Supervisors / Marin County Transit	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)	131, 142
	Board of Supervisors / Marin County Transit	Transit Management	Manages and operates transit routes serving parking lots	106, 109, 114, 127, 131
	Board of Supervisors / Marin County Transit	Transit Vehicle	Provides transit access to GGNRA park sites	131
	Board of Supervisors / Marin County Transit	Vehicle	Vehicle equipment of transit vehicle	131

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Entity	Division	Label	Description	Page
MTC - Metropolitan Transportation Commission	511 Traveler Information	Information Service Provider	Collects and repackages information to make it useful to visitor	100, 103, 107, 109, 111, 114, 115, 120, 127 , 128, 129, 131, 135, 144
	511 Telephone Number	Telecommunications System for Traveler Information	Telephone interface for traveler information	127
NPS - National Park Service	GGNRA Interpretation	Park Management*	Collects visitation statistics (visitors, cars, tour buses, transit riders, bicyclists, pedestrians)	104 , 106
	GGNRA Maintenance and Engineering	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park	106, 109, 120, 127, 129
	GGNRA Office of Special Park Uses	Event Promoters	Provide information on events, and estimated traffic impacts	105 , 120
	GGNRA Planning and Technical Assistance	Archived Data Management	Collect historical parking, traffic and weather data, work zone and special event activity	99, 100, 102, 104, 106 , 111, 117, 120, 122, 126, 128, 129, 130, 131
		Archived Data User Systems	Uses data collected by GGNRA	102 , 106
	GGNRA Public Safety	Emergency Management	Park staff responsible for responding to emergencies	100, 107 , 108, 109, 120, 123, 124, 126, 127, 130
		Emergency Vehicle	Park vehicles used in emergency response	107, 108
	GGNRA TBD	Information Service Provider	Collects and repackages information to make it useful to visitor	103, 107, 109, 111, 113, 114, 115, 120, 127, 128, 129, 131, 135, 139, 144
		Other Parking	Represents other parking facilities with which GGNRA may coordinate	110, 111
		Parking Management	Tracks parking availability for all parking facilities related to GGNRA	106, 109, 110, 111, 112, 120, 127, 137, 140, 144
		Parking Operator	Human operator who tracks parking availability for the park	111, 112
		Remote Traveler Support (Kiosk)	Provides access to web page and visitor information at key park sites	109, 113 , 142

Entity	Division	Label	Description	Page
National Park Service (cont.)	GGNRA TBD	Remote Traveler Support (Transit)	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)	109, 114 , 127, 131 , 136, 142
		Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs	106, 109, 115 , 116 , 117 , 118 , 119 , 120, 127, 132, 133, 134, 138, 141
		Traffic Management	Assesses current and future congestion on park roadways and determines traffic, parking, and emergency information to present to visitors	98, 99, 100, 105, 106, 107, 109, 111, 115, 116, 117, 118, 120, 121, 122, 125, 127, 128, 129, 130
		Traffic Operations Personnel	Human operator who interprets data processed by traffic management system	120, 121
		Transit Management	Manages and operates transit routes serving parking lots	106, 109, 114, 127, 131
		Transit Vehicle	Provides transit access to GGNRA park sites and parking lots	131
		Vehicle	Vehicle equipment of transit vehicle	131
	Western Resource Center	Archived Data User Systems	Uses data collected by GGNRA	102, 106
Other	GPS Provider	Location Data Source	Provides geographic reference base	131
	Parking facility managers	Other Parking	Represents other parking facilities with which GGNRA may coordinate	111, 140
	National Weather Service	Weather Service	Provides current and forecast weather conditions	106, 109, 120, 127, 128
		Environment	Includes images of current weather conditions and natural surroundings	115, 138
		Financial Institution	Enables the electronic transfer of funds from the user to the service provider	109, 139
Public	Visitors	Basic Vehicle	Receives information on parking availability and emergencies	118, 125, 132
	Visitors	Driver	Receives information on parking availability and emergencies	98, 116, 119, 133 , 136

Entity	Division	Label	Description	Page
Public	Visitors	Event Promoters	Theses entities plan events at or near GGNRA sites in such a way that there will be a significant traffic impact. They are therefore responsible for coordinating traffic management strategies with GGNRA	120, 121
l		Pedestrians	Pedestrians and bicyclists using trails at GGNRA	119, 134
	Visitors	Personal Information Access	Provides pre-trip and transit information to visitors on their own device (personal digital assistant, cell phone, etc.)	109, 127, 135 , 142, 143
	Facility managers (hotels, airport, GGNRA, etc.)	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)	103 , 109, 127, 142, 143
	Kiosk/Terminal Owners for example, hotels and airports	Remote Traveler Support	Provides pre-trip traveler information at fixed locations (hotels, airports, etc.)	103, 109, 142
	Manager of Parking Lot	Remote Traveler Support	Provides information at transit stop of next scheduled transit arrival	109, 142
	Visitors	Traffic	Vehicle traffic on roads accessing park sites	99, 115, 117, 122, 141
	Visitors	Transit User	One who is parking their vehicle at the lot and will use transit	114, 133, 136
	Visitors	Traveler	Anyone who is using the transportation system in the vicinity of GGNRA lands	103, 113, 131, 135, 142
	Visitors	Traveler Card	Enables transfer of electronic information from the user to the service provider	103, 135, 143
	Visitors	Vehicle	Vehicle in vicinity of park sites that may be affected by emergency response	109, 111, 127, 144
	Visitors	Vehicle Characteristics	Vehicle count information for parking lot occupancy counts	111, 137
SF – City/County of San Francisco	Parking and Traffic, Department of	Other TM / Traffic Management	Assesses current and future congestion on park roadways; provides processed traffic data (volume, speed, etc.); and determines traffic and emergency information to present to travelers	106, 107, 120, 130

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Entity	Division	Label	Description	Page
SF – City/County of San Francisco (cont.)	Public Works Department	Maintenance and Construction Management	Manage work zone activities that may affect capacity on roadways serving park	106, 109, 120, 127, 129
	Parking and Traffic, Department of	Roadway	Provides images of roads, parking lots, and park sites; collects raw traffic data; and provides information to visitors via highway advisory radio and changeable message signs	106, 120, 122 , 141
San Francisco MUNI	Transportation	Remote Traveler Support	Provides transit information (schedules, real-time arrival info, etc.) at transit stops and other facilities (hotels, airport, visitor centers, etc.)	131 , 142
	Transportation	Transit Management	Manages and operates transit routes serving park sites, parking lots, and other regional destinations	106, 109, 114, 127, 131
	Transportation	Transit Vehicle	Provides transit access to GGNRA park sites and parking lots	131
	Transportation	Vehicle	Vehicle equipment of transit vehicle	131

* - Extension to National ITS Architecture






Caltrans District 4 Traffic Management Center

Caltrans District 4 Transportation Operations Personnel



Caltrans District 4 Transp. Planning and GGNRA Planning & Technical Assistance





Facility Managers (Hotels, Airports) – Remote Traveler Support

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GGNRA Interpretation – Park Management



GGNRA Office of Special Park Uses and General Public – Event Promoters





GGNRA Planning and Technical Assistance – Archived Data Management

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GGNRA Public Safety – Emergency Management Subsystem

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GGNRA Park Police – Emergency Vehicle Subsystem





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GGNRA – Other Parking Lots





GGNRA – Parking Management Subsystem

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GGNRA – Parking Operator



GGNRA – Remote Traveler Support (Kiosks)



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GGNRA – Remote Traveler Support (Transit)

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GGNRA – Roadway Subsystem (Changeable Message Signs)



GGNRA – Roadway Subsystem (Detectors)



GGNRA – Roadway Subsystem (Highway Advisory Radio)



GGNRA – Roadway Subsystem (Ped/Bike Crossing)



NPS Public NPS **Event Promoters** Weather Service NPS Roadway an Francisco Caltrans CCTV **Traffic Operations** Personnel weather Traffic Traffic information Management Management SF traffic **NPS - GGNRA** operator event data Roadway traffic plans Archived Data operator Detectors traffic Management traffic traffic inputs images information information traffic video coordination coordination archive СТ MC surveillance data control Roadway archive NPS status Detectors Information archive requests Service Provider road network traffic conditions flow NPS request for road Traffic NPS traffic flow network conditions Roadway traffic flow traffic images Management Detectors Information road network conditions traffic sensor control Service Provider request for road roadway information system status network conditions roadway information system data roadway information parking demand system status management request roadway information parking lot data request system data Marin County parking information roadway information parking demand management response system status work roadway information parking availability Roadway zone system data resource deployment status HAR roadway information information incident information system status incident information roadway information NPS resource request system data NPS NPS NPS MC S NPS Caltrans Roadway HAR Maintenance and Parking Emergency Roadway Roadway Construction Management Management CMS CMS Management

GGNRA – Traffic Management Subsystem

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GGNRA – Traffic Operations Personnel





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Local Law Enforcement – Other Emergency Management Agencies



Local Public Safety Answering Points



Marin County Office of Emergency Services – Highway Advisory Radio



Marin County Traffic Management Center







National Weather Service

Road Maintenance and Construction Agencies

The following agencies are included:

- Caltrans District 4 Highway Operations / Maintenance
- GGNRA Maintenance and Engineering
- Golden Gate Bridge, Highway and Transportation District, Bridge Division
- Marin County Department of Public Works, Roads Division
- City and County of San Francisco Public Works Department





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Transit Providers

The following agencies are included:

- GGNRA Parking Lot Shuttle Service
- Golden Gate Bridge, Highway and Transportation District, Transit Division
- Marin County Transit
- San Francisco MUNI






Visitors – Pedestrians





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Visitors – Transit User



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Visitors – Vehicle Characteristics

Public				
Vehicle Characteristics				
vehicle characteristics				
NPS				
Parking Management				

Other – Environment







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Other – Financial Institution

Financial Institution				
tr	ansaction status	payr req	ment uest	
NPS				
	Information Service Provider		ər	









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Other – Vehicle



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APPENDIX D: MEMORANDUM OF UNDERSTANDING

A copy of the Portable Changeable Message Signs Memorandum of Understanding between Caltrans and Golden Gate National Recreation Area will be added here when it is finalized.

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