IEEE P802.11
Wireless LANs

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| Use Case Reference List for TGai |
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Abstract

The most current version of this document contains the descriptions of the use cases that will be used to evaluate submissions to TGai.

The document now has numbered sections for reference to/from presentations. The clause numbers are meant to be stable over time to allow for continued use case reference by number.

--Tom

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# Introduction

IEEE 802.11 devices are increasingly becoming more mobile devices. TGai project’s primary need comes from an environment where a large number of mobile users are constantly entering and leaving the coverage area of an extended service set (ESS). Every time the mobile device enters an ESS, the mobile device has to do an initial set-up with an access point (AP) to establish wireless local area network (LAN) connectivity. This works well when the number of new stations (STAs) in a given time period is small. It requires efficient mechanisms that scales well when a high number of users simultaneously enter an ESS. This requires the ESS to minimize the time the STAs spend in initial link setup, while maintaining secure authentication.

The goal of this document is to assist in the process of turning use cases submitted to TGai into prototypical use cases. These prototypical use cases will then in turn be used to yield set of requirements that will be used to judge the utility of proposed text for 802.11ai.

Section 2 of this document is a summary all use cases presented to and accepted by TGai. The intent is to gather all use cases and group them into categories of similar traits. These combined use cases are the source for the prototypical use cases listed in Section 3.

Section 3 establishs a small set reference use cases for the purpose of evaluating proposals to TGai. It combines use cases which have the very similar requirements and is an abstracted use case rather than a specific scenario.

#  Use Cases

The purpose of this document is to gather all use cases that will be considered in the evaluation of proposed updates to IEEE 802.11 that would decrease the link setup time. TGai may determine that some of the use cases contained in this document are required to be satisfied, while others may be desired but optional. In any case, no requirements for technical solutions are required to address issues other than those stated or implied by the use cases in the most current version of this document.

## General Methodology

The basic use case methodology to be used by TGai is explained in 11-11-0191-00-01ai-Use-Case-Discussion.pptx. General use case methodology has four basic elements:

* Actor(s)
* Devi ce sets
* Goal
* Scenario(s)

For TGai, the use cases are somewhat simplified because of the limited scope of the PAR.

## Use Case Traits for TGai

Actors generally define unique characteristics of operators of the devices involved. For all cases considered by TGai, the initiator STA and the target ESS are constant. The STA may be autonomous or operated by a human, but its relationship to the ESS remains the same. If more than one device/person is present in the ESS, that difference should be noted in the description of the scenario. Other important factors, such as relationship between STA and the ESS in terms of assumed level of trust and previous history are also best described in the scenario.

Device sets are the STA, AP, and any other relevant equipment needed to accomplish the intended tasks withing the ESS. For TGai, the device set of interest is always a STA and an AP.

Each of the use cases also have (or will have) the determination of the level of difficulty to achieve with the now-current 802.11 technology. The traits which differentiate the use cases are sumerized in a table at the end of each use case description. The traits, defined below, are “xxx1”, “xxx2”, “xxx3”, and “xxx4”. An expected value or each of these traits is listed as well as a general indication of difficulty in terms of high, medium, low.

* High = hard to achieve
* Medium = nominal behaviour, expected to be achieved with current technology
* Low = easy to achieve

### xxx1

Xxx1 is the number of STAs attempting to establish for the first time a link to an AP within an ESS as measured over a one second time interval.

* High: more than 50
* Medium: 10 to 49
* Low: less than 10

**Link Attempt Rate** 🡨

**Rate of STA Entry**

**Rate of initial link request**

### xxx2

Xxx2 is the “busyness” of the wireless medium of the ESS. It is measured as the percentage of time the medium is in use.

* High: More than 50%
* Medium: 10 to 50%
* Low: Less than 10%

Media usage

Channel usage

### xxx3

Xxx3 is the time the STA is within the range of an AP within an ESS. This time is the maximum available time for establishing a link and exchanging data.

* High: less than 1 second
* Medium: between 1 and 10 seconds
* Low: more than 10 seconds

STA dwell time

Time Envelope

Available time

### xxx4

Xxx4 is the amount time required to establish for the first time a link to an AP within an ESS. This includes the time for AP/Network discovery and (secure) Association and Authentication

* High: less than 100 ms
* Medium between 100 ms and 2 seconds
* Low: more than 2 seconds

NOTE: “link”, “association”, “authentication” are defined as per 802.11

We need to agree when to start measuring this time interval (e.g. when the STA enters the coverage of the ESS, etc.)

Link Set-Up Latency

Link Set-Up Time

 For each of the use cases that have the same characteristics, the following table will be filled in:

|  |  |  |
| --- | --- | --- |
| Trait | Expected Value | Difficulty designation |
| Xxx1 |  |  |
| Xxx2 |  |  |
| Xxx3 |  |  |
| Xxx4 |  |  |

# Use cases

For the purposes of organization, the use cases below are gathered together in terms of the mobility of the STA. The AP is assumed to be fixed, unless otherwise stated.

## Pedestrian

### Electronic Payment

For pedestrian use, the STA (the payee) will typically be located in a kiosk or at a retail store counter and the AP will be part of the retail infrastructure. After bringing purchases to the checkout counter, or at the pickup window of a drive-through store, the customer elects to pay electronically using their Wi-Fi capable smart phone or hand-held computer. The time-critical aspect of the transaction is that the mobile STA may not be within range of the fixed AP until moments (only a second or more) before the transaction is to be completed. In high traffic scenarios, conventional delays in establishing a link can cause unacceptable delays with long lines forming at the counter.

|  |  |  |
| --- | --- | --- |
| Trait | Expected Value | Difficulty designation |
| Xxx1 |  |  |
| Xxx2 |  |  |
| Xxx3 |  |  |
| Xxx4 |  |  |

### Traveller Information

A pedestrian walking down the street, opting to see tourist information about current location. Ability to get map, navigation directions, local attractions, restaurants, etc. Unlike things like the iPhone app “AroundMe”, the information provided would be even more site specific and could be interactive.

Museum attendee –The person obtains information about an object on display as they walk up to the object. Instead of the current recorded voice guides currently in use, this service would be automatically activated by the current location, within a meter or two if necessary, of the user and could even take into account the direction the person is looking in. The information could be multimedia and be interactive.

Knowledge of real-time weather conditions (rain, ice, snow, temperature) along an anticipated route can help a traveler (a potential motorist, transit user, pedestrian or bicyclist) determine whether to reschedule or postpone the trip, or take an alternate route or mode. This application includes continuously collecting weather-related probe data generated by probe vehicles, analyze, and integrate those observations with weather data from traditional weather information sources, and develop highly localized weather and pavement conditions for specific roadways, pathways, and bikeways. The role of 802.11ai is to provide a means of disbursing the current and forecasted information via the Internet and personal communication devices at high density user locations where devices will have relatively short dwell times such as rail/transit stations.

### Internet Access

Mobile devices perform Internet access while walking. There is the possibility of the person running, not just walking, such as when a jogger is asking for streaming music.

### Mobile Accessible Pedestrian Signal System

This application integrates information from sensors commonly available on a smart phone, and then wirelessly communicates with the traffic signal controllers to obtain real-time Signal Phasing and Timing (SPaT) information, which will then be used to inform visually impaired pedestrian as to when to cross and how to remain aligned with the crosswalk. The application will allow an “automated pedestrian call” to be sent to the traffic controller from the smart phone of registered blind users after confirming the direction and orientation of the roadway that the pedestrian is intending to cross. The traffic controller can hold or extend the walk signal until the visually impaired pedestrian has cleared the crosswalk. In addition, the application would also enable communications between vehicles and the pedestrian (V2P) at intersection crosswalks. Drivers attempting to make a turn will be alerted of the presence of a visually-impaired pedestrian waiting at the crosswalk. The application can also warn the pedestrian not to cross when an approaching vehicle is not likely to stop at the crosswalk while the light is transitioning to red for automobiles. The V2P concept can also be applied to alert drivers of the presence of non-visually impaired pedestrians and bicyclists, and vice versa, increasing safety of the non-motorized traveler. IEEE 802.11ai APs may be a cost effective alternative for intersections not equipped with public sector IEEE 802.11p RSEs.

## Vehicle

### Electronic Payment

Fuel payment – This is like the conventional gas station pump credit card payment except that the charge is being made electronically via a Wi-Fi connection. The only need for low latency in this scenario is the potential delays that would be objectionable to the driver before pumping can begin.

Rental car processing – As a rental car drives through the gate upon returning, all relevant data is automatically transmitted to the office and the car “checked in”. The car’s diagnostic connector supplies key information such as the vehicle ID, mileage, fuel level, and any diagnostic codes that appeared. All electronic fees paid for by the on-board systems, such as tolls, parking, fuel, or retail sales, that were charged are added to the rental bill. This not only improves the check-in procedure, but also allows rental cars to use electronic toll collection and parking, which they cannot easily do today.

Fuel payment – This is like the conventional gas station pump credit card payment except that the charge is being made electronically via a Wi-Fi connection. The only need for low latency in this scenario is the potential delays that would be objectionable to the driver before pumping can begin.

### Traveller Information

Special maps and directions being downloaded as needed. Such downloads could occur spread out over multiple APs to distribute the download time. For commercial trucks, this could include downloading special routing and delivery instructions from their dispatcher and automatically updating the dispatcher with their status and location.

Car driver – The driver (or passenger) obtains information about upcoming road conditions and travel times from a roadside AP. Could be expanded into automatically diverting traffic to alternative routes and providing turn-by-turn directions while on these detours. Each vehicle would be assigned to a specific route and thus may be getting unique directions.

Curbside Parking Availability System -- Travelers desire to know of available parking spaces in real time via the Internet as well as via navigation devices (handheld devices, in-vehicle systems). Parking information will include the location, rate, type, and hours. The information on available spaces will be sent from the fixed sensors or the vehicles to a central server for processing. Travelers access the real time parking information via an IEEE 802ai AP wherever coverage is available either prior to or during a trip and can receive updates en-route. APs can be strategically placed in the vicinity of the parking areas to assists motorists finding spaces.

Multi-modal Real-Time Traveler Information -- This multi-modal application uses real-time data and communications capabilities to empower travelers to make informed travel choices in real time, pre-trip and en-route. Based on real-time and historical travel conditions for the traveler’s trip (pre-specified origin, destination, and time of departure) the application will suggest potential routes and modes (e.g., auto, transit, bicycle, walk) with approximate travel times, travel time reliability, and costs for each alternative. If transit is included in one of the alternatives, locations of transit stations, arrival time of next bus or train, parking availability and cost, will be also be provided. The application will “predict” travel times based on existing and predicted traffic congestion, weather and pavement conditions, incident locations, work zone locations and timings, transit availability and schedule, parking availability, possible use of HOT and HOV lanes (depending on time of travel). Information may be provided via: personal mobile devices, transit stations on vehicle interactive screens, in-vehicle devices, internet, and 511. TGai APs can be used for Internet connections and communications with both in-vehicle and personal mobile devices.

Dynamic Speed Harmonization -- This application will be used to monitor real-time traffic and weather data to check if lane-specific speeds within a pre-specified zone indicate the onset of congestion or an increased risk of freeway breakdown conditions. If congestion precursors such as unstable flow patterns, are either detected (in the near-term) or predicted (in the longer-term), the application will calculate and communicate lane-specific target speeds within as well as upstream of the impending bottleneck to motorists via dynamic signs placed on overhead gantries, RSEs to vehicles with range; and from vehicle to vehicle. When RSEs are not available, IEEE 802.11ai APs may be a viable alternative.

### Internet Access

A person in a car requesting Internet access at any time under any driving circumstances in which there is available coverage. This may be within a parking garage to obtain information about stores in the area or it could be along the roadside for Web access or to download files or streaming audio/video.

### Emergency Services

Traffic Signal preemption – Currently, many emergency vehicles are capable of causing a red traffic light to turn green via strobe light communication with the traffic signal controller. Using 11ai, this capability can be greatly expanded, not only in terms of the operating range, but also to take into account the navigation plan of the vehicle so that other lights in the area can be controlled to clear traffic in advance of the emergency vehicle’s arrival at the intersection, but to account for planned turns. This can include video of the scene they are going to and updated navigation directions to account for previously unknown problems.

An extension of this application is the ability for the emergency vehicle to directly communicate with private sector vehicles ahead of it (and those approaching on cross streets) that they are approaching, from which direction they are approaching, and especially important in congested urban areas, if they desire the private vehicle to move to the right or the left depending on the needs for clearing the intended path.

Ambulance interaction with hospital – an ambulance can upload vital patient information to the hospital they are going to (or to any other specialists that need to be consulted) while en-route. Such data may include video as well as instrument readings. If the AP is available, such data can be uploaded prior to leaving the scene, perhaps as a means of better defining the best course of action.

On-site emergency services coordination – Establish a temporary IP network on-site to go beyond what can be done with simple voice-based systems. In addition to voice, text, and graphics (e.g. building plans), video from a variety of sources can be shared by all on-site responders and shared with fixed site control centers.

Public Interaction – During an emergency situation, there is a need for improved communication between the emergency services agencies and the public, whether this is to on notice about a situation, to assist in looking for someone (e.g Amber alert) or to conduct an evacuation of an area. The public can be advised about actions that they should take that is specific to their location (don’t send out a city-wide evacuation when only a small specific area is involved) and manage the routing of cars and people to avoid grid-lock for either an evacuation or simply when temporarily rerouting traffic.

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders

Staging/positioning of public safety vehicles arriving at an incident is typically handled ad hoc. However, task force and mutual aid response may involve pre-planned procedures and pre-deployment of assets. Pre-arrival situational awareness is critical to public safety responder vehicle routing, staging and secondary dispatch decision-making. Still or video images of an incident scene, surrounding terrain, and traffic conditions would be valuable input to responder and dispatcher decisions and actions. Incident status information relayed to both en route vehicles and vehicles at the incident command area could help in establishing safer, possibly less traffic-impeding incident response. Traffic camera images would be routed to moving vehicles via roadside infrastructure (still images or video depending on capabilities). Public safety dispatcher(s)/incident commander would make pre-arrival staging decision based on available data (initial responder reports; vehicle sensors; imagery). Staging plans (possibly graphic/map based) would be transmitted to emergency vehicles en route and upon arrival. Portable IEEE 802.11ai APs can be deployed at the incident management command location to disseminate the appropriate information to arriving vehicles and to responders with portable devices. APs deployed en-route may also provide the information prior to arrival.

### Inspections

Vehicle safety – There are requirements for operators to not simply keep their vehicles in a safe condition, but to keep records and undergo occasional safety inspection. Using the capabilities of 11ai, the on-board records can be downloaded to a certified inspection station without the vehicle having to stop and physically hand over these records (electronic screening). This would expand on the currently implemented weight-in-motion systems, with the weigh-in-motion function being included in the same system.

Hazardous Goods (HazMat) – This would enable the automated monitoring and tracking of shipments of hazardous goods (also known as Hazardous Materials or HazMat). Such shipments have prior approval, not only of the goods themselves, but the route to be taken, with considerable paperwork for the various aspects of the shipment. With the capabilities of 11ai and the existence of various roadside APs, the shipment can be tracked in real time, including monitoring the status of the goods and any on-board security systems.

Border Crossing – All of the necessary paperwork, including driver information (which can include biometrics) can be transferred to the boarder inspection station as the vehicle is approaching the station. Many border crossings have periods of congestion that result in long backups which not only cause a waste in time, but also can cause traffic management problems.

### Resource Management

Vehicle tracking – All fleets attempt to keep track of all of their vehicles at all times. Widespread Wi-Fi hot spots along roadways and throughout urban areas can be used by trucking fleets to quickly link to their home office to not only indicate where they are located, but at the same time to download any necessary updates to the driver.

Dynamic Load Allocations and Routing and fleet management – Currently, especially with Less Than Truckload (LTL) fleets, there is a need to provide dynamic rerouting of a truck to pick up a previously unscheduled load. This is currently done via cellular phones and satellite systems, but would be much more efficient using Wi-Fi. In doing so, with the additional bandwidth available, navigation updates can be made towards the new destination which take into account all other stops that will be required during that day (a capability that is beyond conventional navigation systems).

## Transit

### Station arrival

A train with no Wi-Fi access arrives at a station and the passengers want to connect to the AP. A small number (less than 25%) of the passengers will remain in the AP range when the train leaves, 90 seconds after arrival.

### Passenger In-transit access

The train is a mobile AP which the passengers connect to whilst travelling. The turnover of STAs accessing the AP will be about 25% every 3 to 5 minutes. Users will not log off when leaving the train.

### Station Lobby

STAs will arrive in a fairly constant rate and want instant access to schedules, status, and optimal transit routes. The transactions may include ticket purchase.

### Connection Protection

Many public transportation trips require multiple transfers which may be between different modes, such as buses, subways, and commuter rails, and are often across multiple agencies. Travelers desire a connection protection request and receive a confirmation based on a set of criteria, indicating whether the request is accepted. For public transit riders experiencing delays, a high volume of requests may be attempted at a single AP necessitating quick authentication and association. Travelers attempting to submit a request may be en-route (moving).

### Dynamic Transit Operations

The traveler uses GPS and mapping capabilities of mobile devices to input a desired destination and time of departure along with their current location. This information will be sent to a central system that dynamically schedules and dispatches or modifies the route of an in-service vehicle by matching compatible trips together. Travelers at rail, subway, or bus transfer stations and depots may present a large volume of requests in a short period of time to a limited number of APs. Travelers may also alter plans or plan a return trip while en-route.

## Switchover

Nokia presentation: switch over via TGu. Social networking 0122.

**References:**

* **11-11-0281-00-00ai-proposed-dynamic-mobility-use-cases-for-tgai.docx**
* **11-11-0148-05-00ai-use-cases-for-tgai.docx**