



# Coordination of Freeway Ramp Meters and Arterial Traffic Signals (FOT)

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## Outlines

- **Project Review - SOW**
- **Traffic Signal Control Interface with 2070**
- **Simulation Development**
- **Discussion**





## Project Review: Objectives – Long Term

- **Large scale system problem:**
  - **Freeway corridor traffic and control**
  - **Related arterial(s) intersections traffic and control**
  - **Dynamic interaction between the two**
- **To resolve any (or potential) inconsistency and conflict between the two traffic control systems;**
- **To balance the traffic flows overall system for accommodating more traffic in peak hours;**
- **To eventually minimize Total Travel Time (TTT) system wide and to improve mobility, reduce emission and energy consumption;**



## Project Review: Objectives – Short Term

- To coordinate one (feeding) intersection and one onramp meter
- To identify
  - Where and when coordination is necessary
  - Where and when is feasible
  - Technical hurdles in coordination of the two subsystems
  - Conflict of interests between the two and how to resolve
- To hopefully improve the performance of the system in some aspect in some level which could be quantified;
- To set an example for overcoming any hurdle(s) caused by multiple jurisdictions;
- To laid down a good foundation for a large project involving a freeway corridor and related arterial corridor(s) if it is successful.



## Traffic Signal Control Interface with 2070 Controller

- **Uses AB3418 protocol (a subset of NTCIP) over COM1 serial port**
- **Uses laptop/PC104 host in place of field master**
- **Currently is a simple utility for sending byte strings to serial port**
- **Eventually will use our publish/subscribe database (db\_slv©) to interface to send timing from optimal control algorithm**
- **Can change max and min green for a given phase**



## Simulation Development

- **Simulation model**
  - **Microscopic simulation**
  - **Network**
    - **Freeway: north of Taylor to south of Julian**
    - **Intersection: Taylor, San Pedro**
  - **Vehicle**
    - **General vehicles**
    - **HOV vehicles**
  - **Demand**
    - **5 min data**
    - **PeMS**
    - **Video**
  - **Control**
    - **Default control is the real timing/metering plan**



# Simulation Development

- **Model Calibration**
  - **Freeway**
    - **Flow, occupancy, speed**
    - **Measurement from loop detector upstream of Taylor on-ramp**
  - **Intersection**
    - **Flow of each movement**
    - **Queue**
  - **On-ramp**
    - **Queue**
  - **10 runs**



# Simulation Development

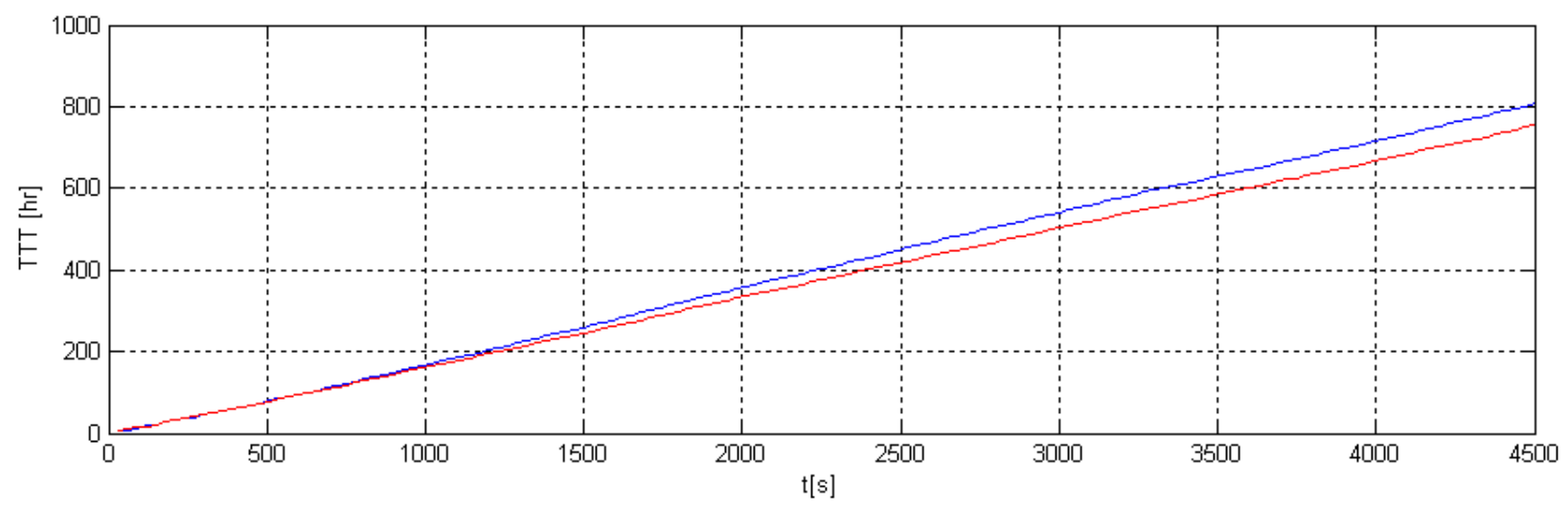
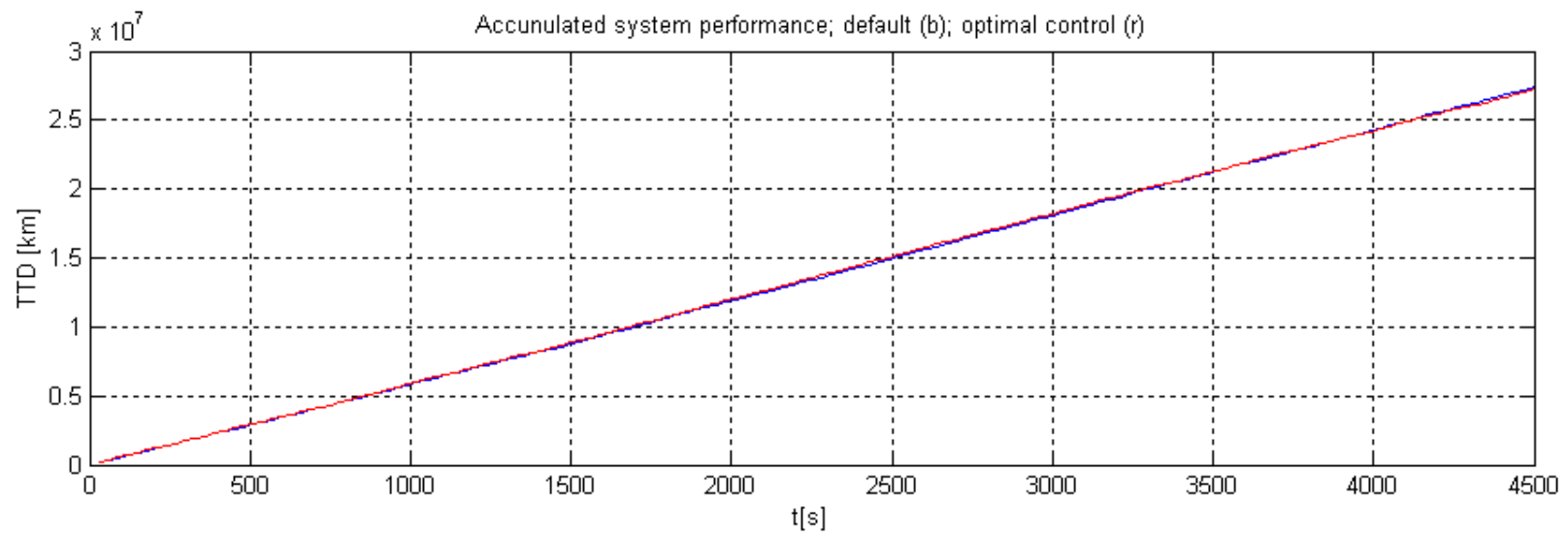
- **Control Strategy Implementation**
  - **Through Aimsun API**
  - **Ramp metering: ALINEA**
    - **Based on occupancy measured from detector upstream of Taylor on-ramp**
    - **Metering rate updates every 30sec**
  - **Intersection: Optimal control strategy**
    - **Assume the demand of each movement is known**
    - **Assume the queue of each movement can be measured**
    - **Minimize the gap between desired green and given green**
    - **Subject to constraints of minimum green time and on-ramp storage**
    - **Green duration updates every cycle**

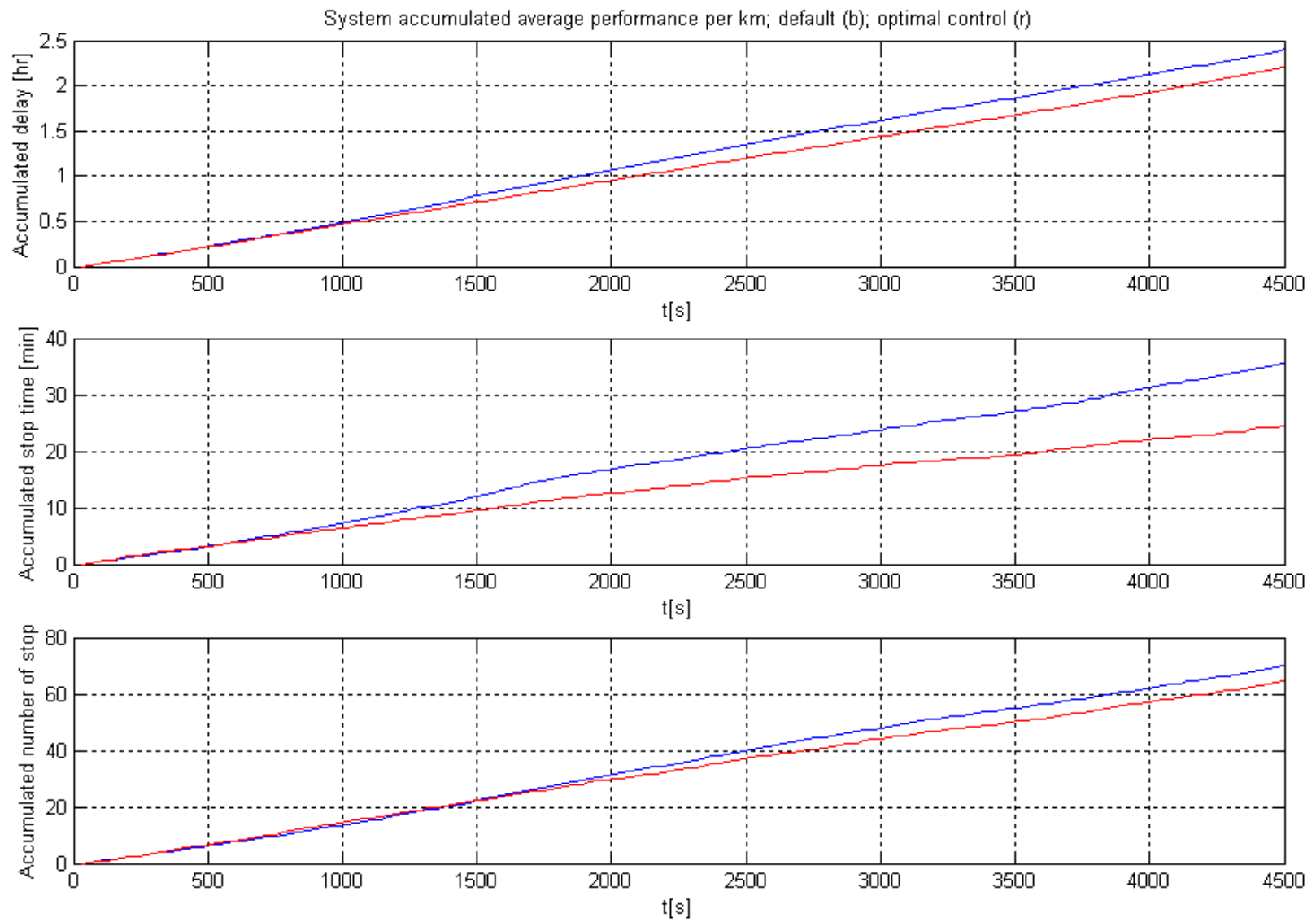


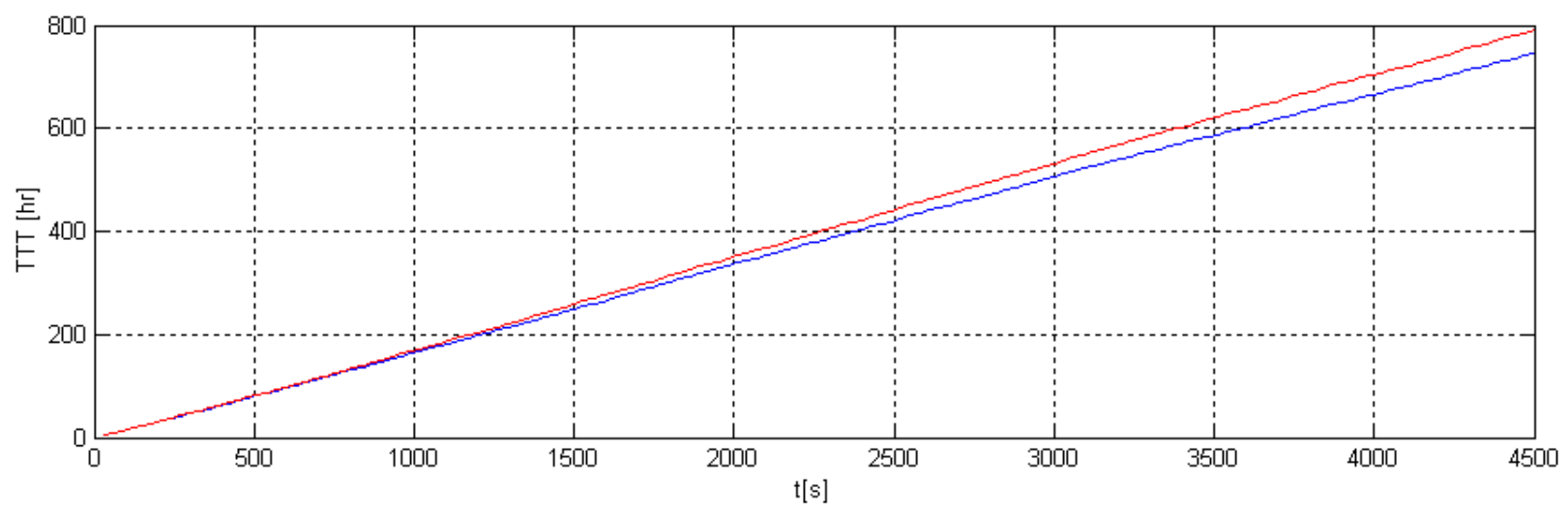
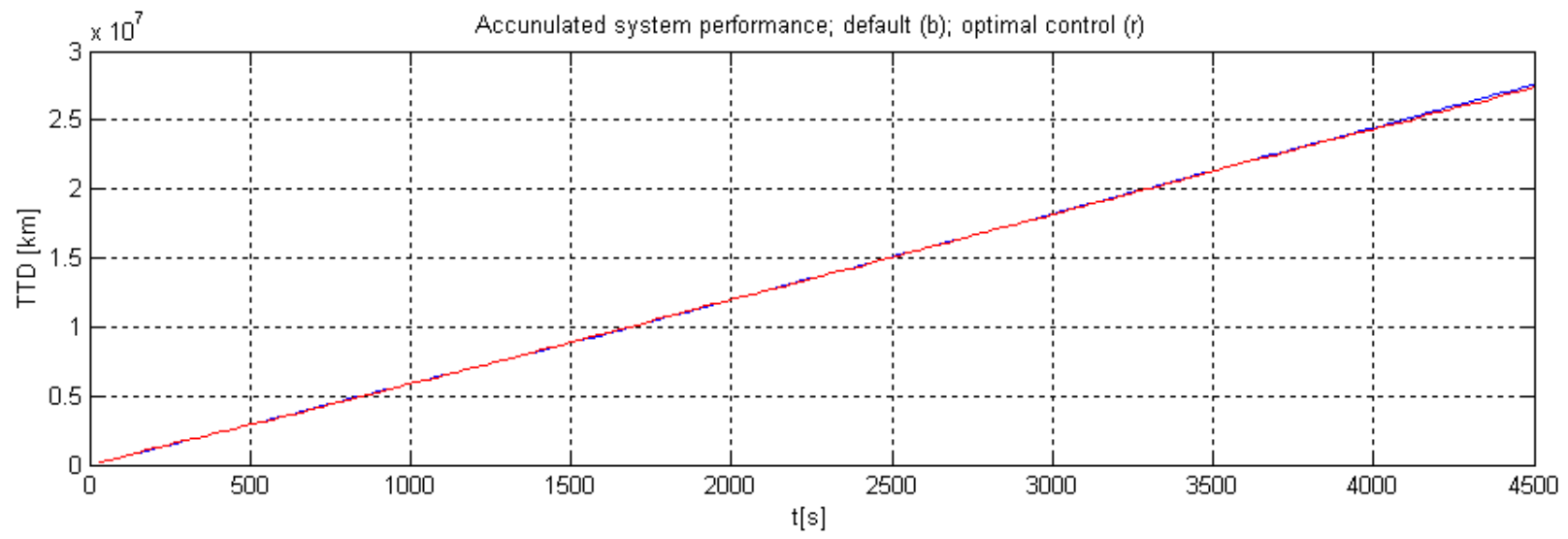


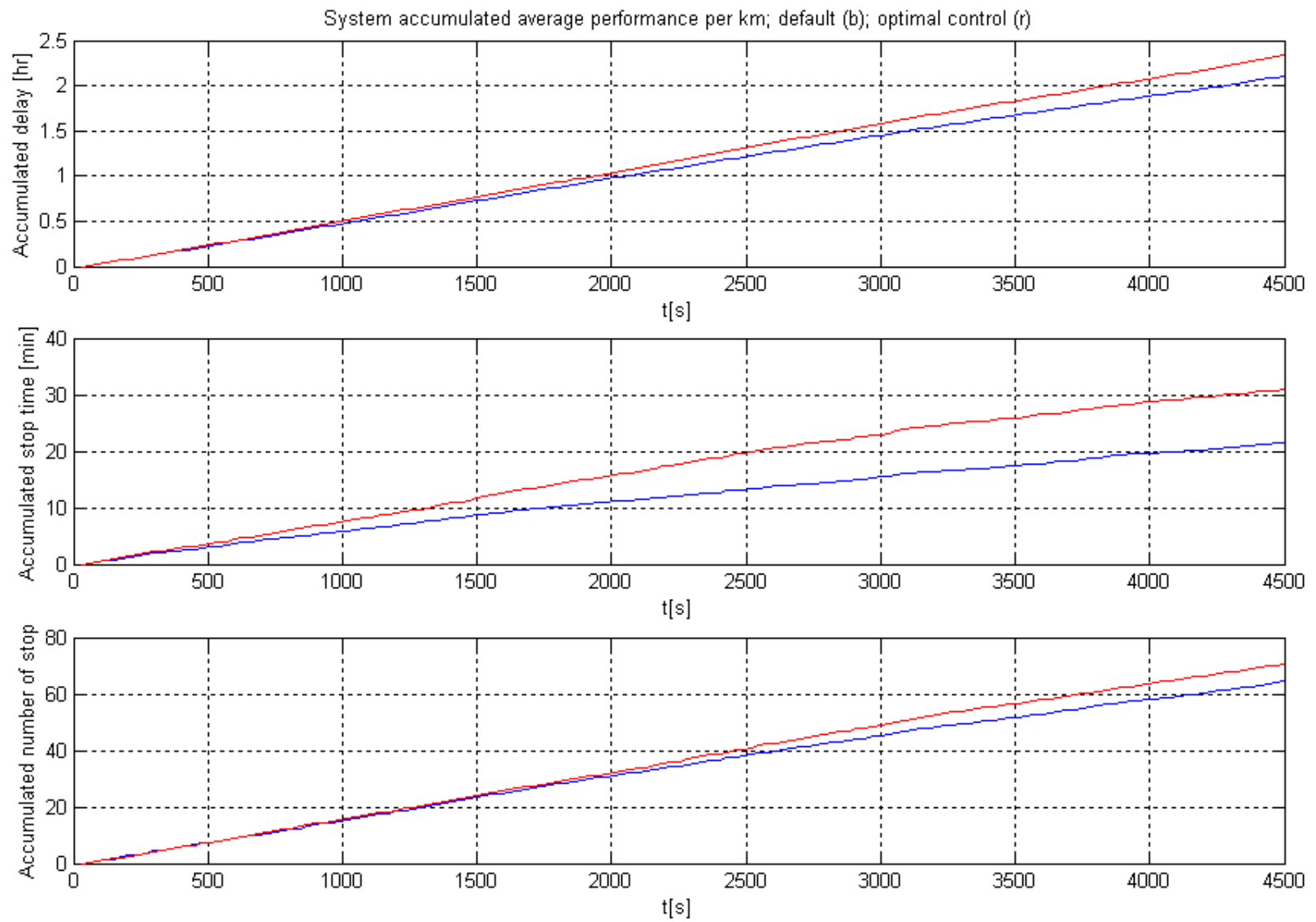
# Simulation Development

- **System Wide Performance**
  - **Parameters used**
    - **TTD (Total Travel Distance)**
    - **TTT (Total Travel Time)**
    - **Accumulated average delay in hours per km**
    - **Accumulated average stop time in hours per km**
    - **Accumulated average number of stops per km**
  - **Results for default control and optimal timing + ALINEA RM**
    - **Mixed up: some replications are better and some are worse**
    - **Depending calibration results for the calibration: better calibration results usually have better performance in optimal timing strategy + ALINEA RM**











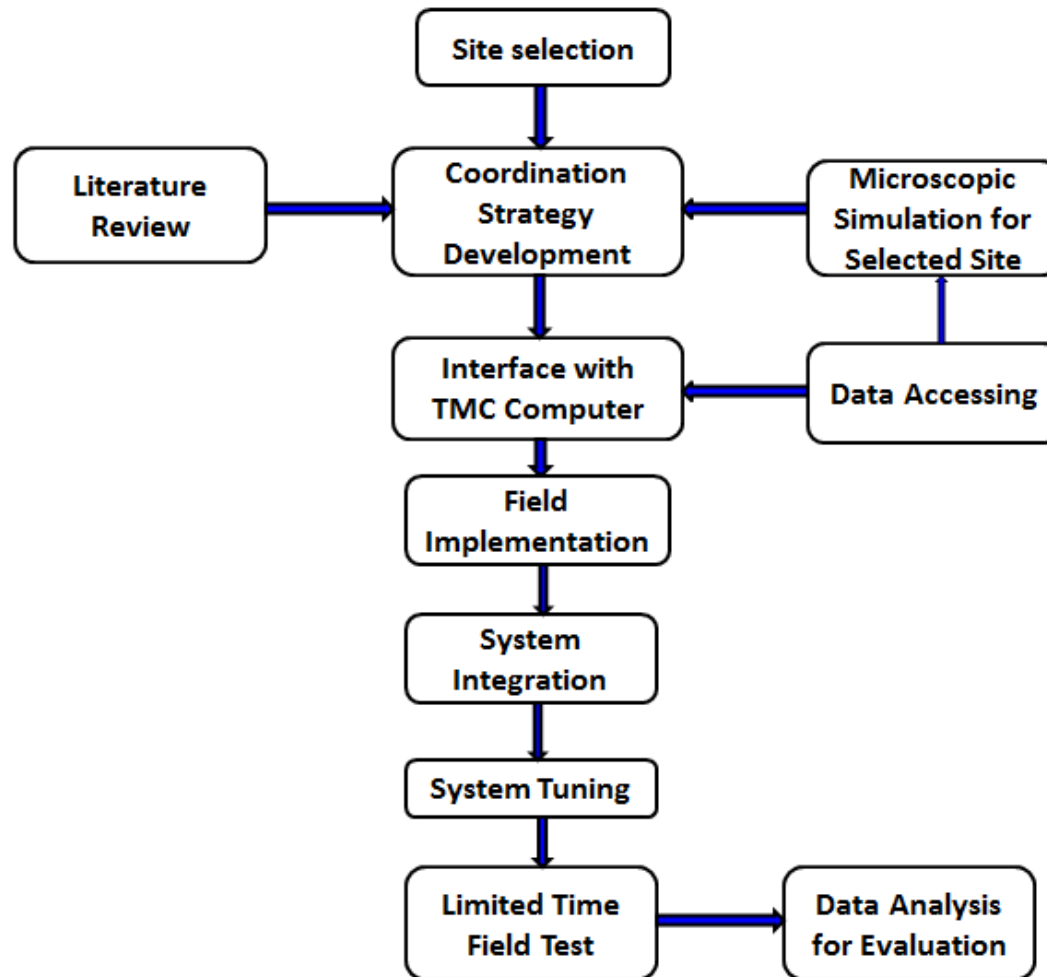
## Simulation Development

- **Problem in Simulation Development:**
  - **Inadequate data:**
    - **Video data is too short in time**
    - **PeMS (or D4) data at VDS402117 (mainline upstream of merging) only has one lane (Ln 2) data**
    - **No detailed San Pedros movement data – the dynamic interaction of the two intersections is unknown (resolution to be 3~5min)**
- **Next Step:**
  - **Extensive data collection at the two intersections necessary**
  - **Data collection at VSD402117 for other lanes necessary**
    - **Needs help of D4 to fix the loop faults for other lanes**
  - **Data collection for merging area using video camera**



## ConOps

- **Work Plan**
- **Interfacing for Dynamic Ramp Metering Rate**
- **Interfacing for Intersection Traffic Signal Timing**
- **Interfacing with 2070 traffic controller**







## Interfacing for Dynamic Ramp Metering Rate

- **Direct Interface with D4 TMC Computer**
  - **To get real-time data**
    - **Mainline detector**
    - **Onramp detector**
  - **To send ramp metering rate for each onramp**

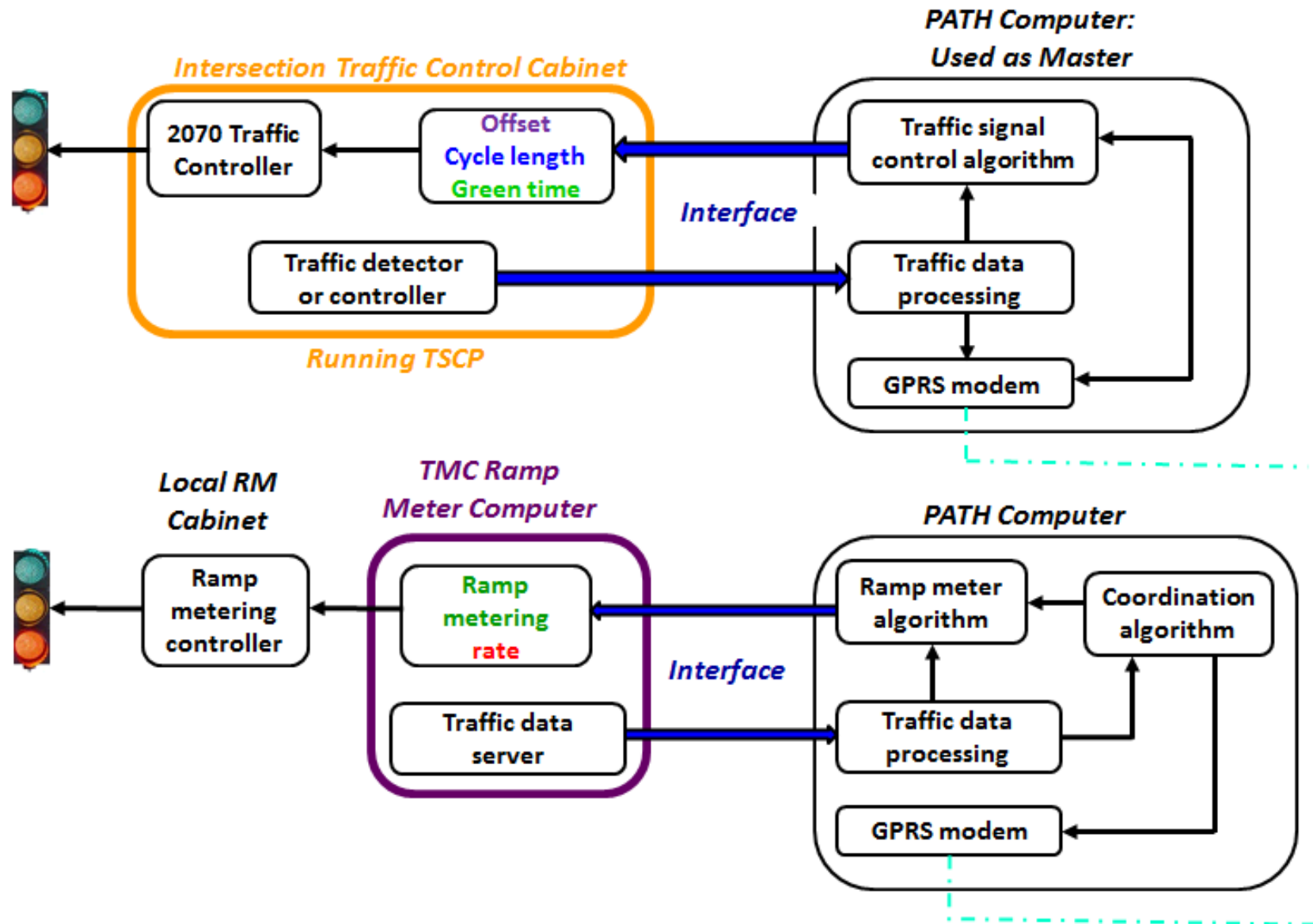


## Interfacing for Intersection Traffic Signal Timing

- **SR87-Taylor Intersection of Caltrans D4 running TSCP**
- **Caltrans D4 Controller Running TSCP without a Master**
- **Caltrans D4 Controller Running TSCP with a Master**
- **San Jose Intersection 2070 Controller running Fourth Dimension Software**
- **San Jose Intersection 2070 Controller running SCATS**

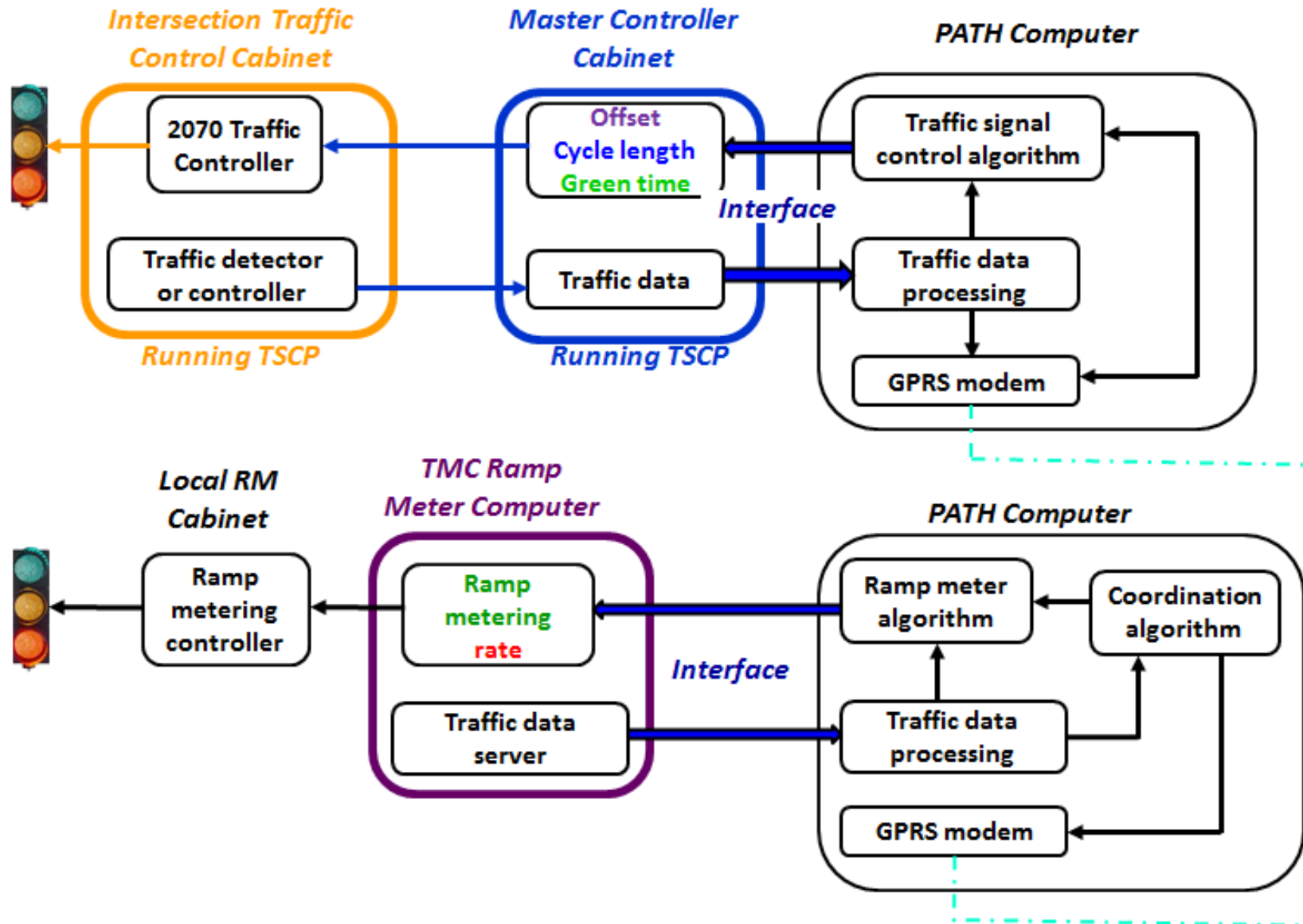


# Caltrans D4 Controller Running TSCP without Master





# Caltrans D4 Controller Running TSCP with a Master

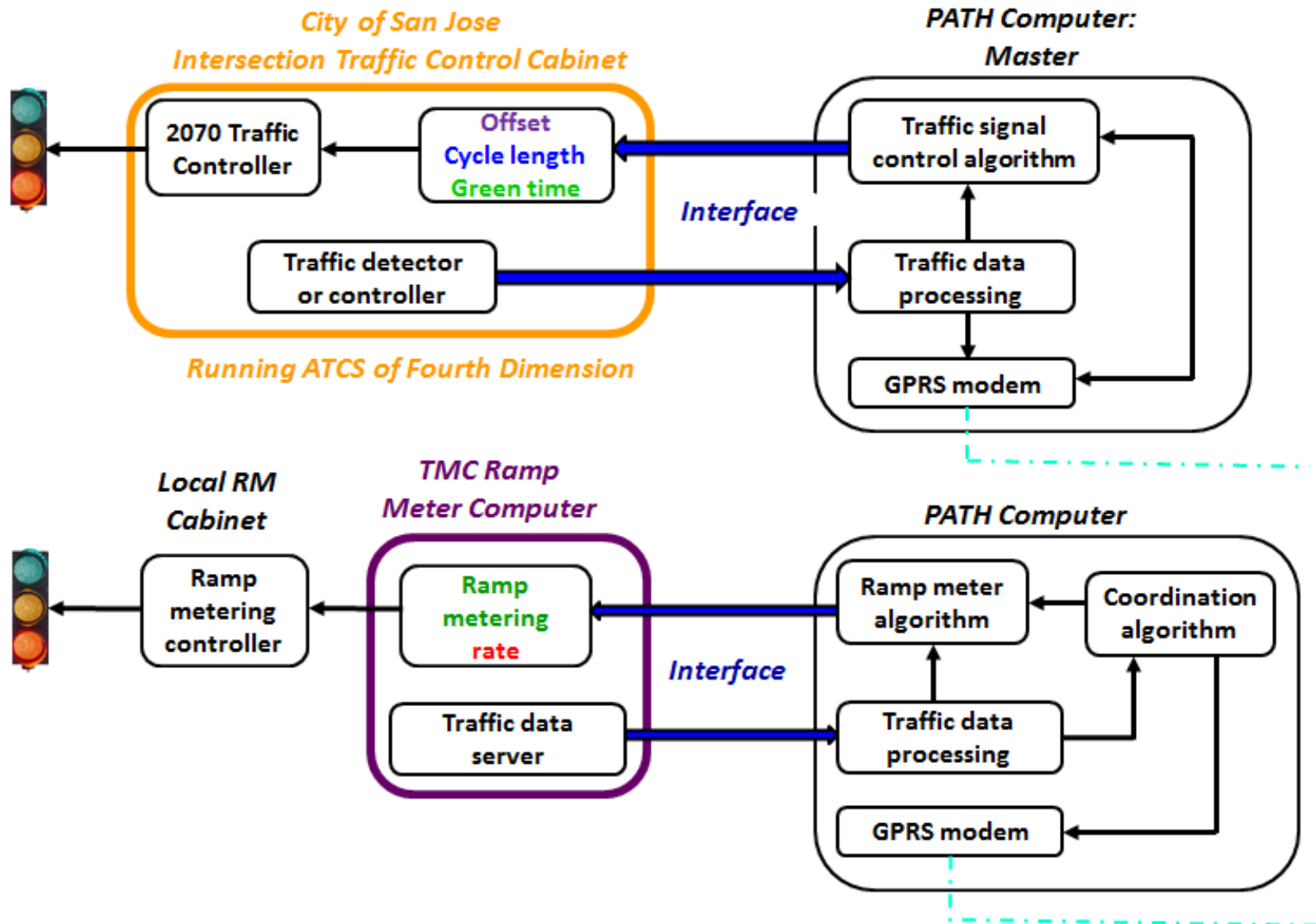




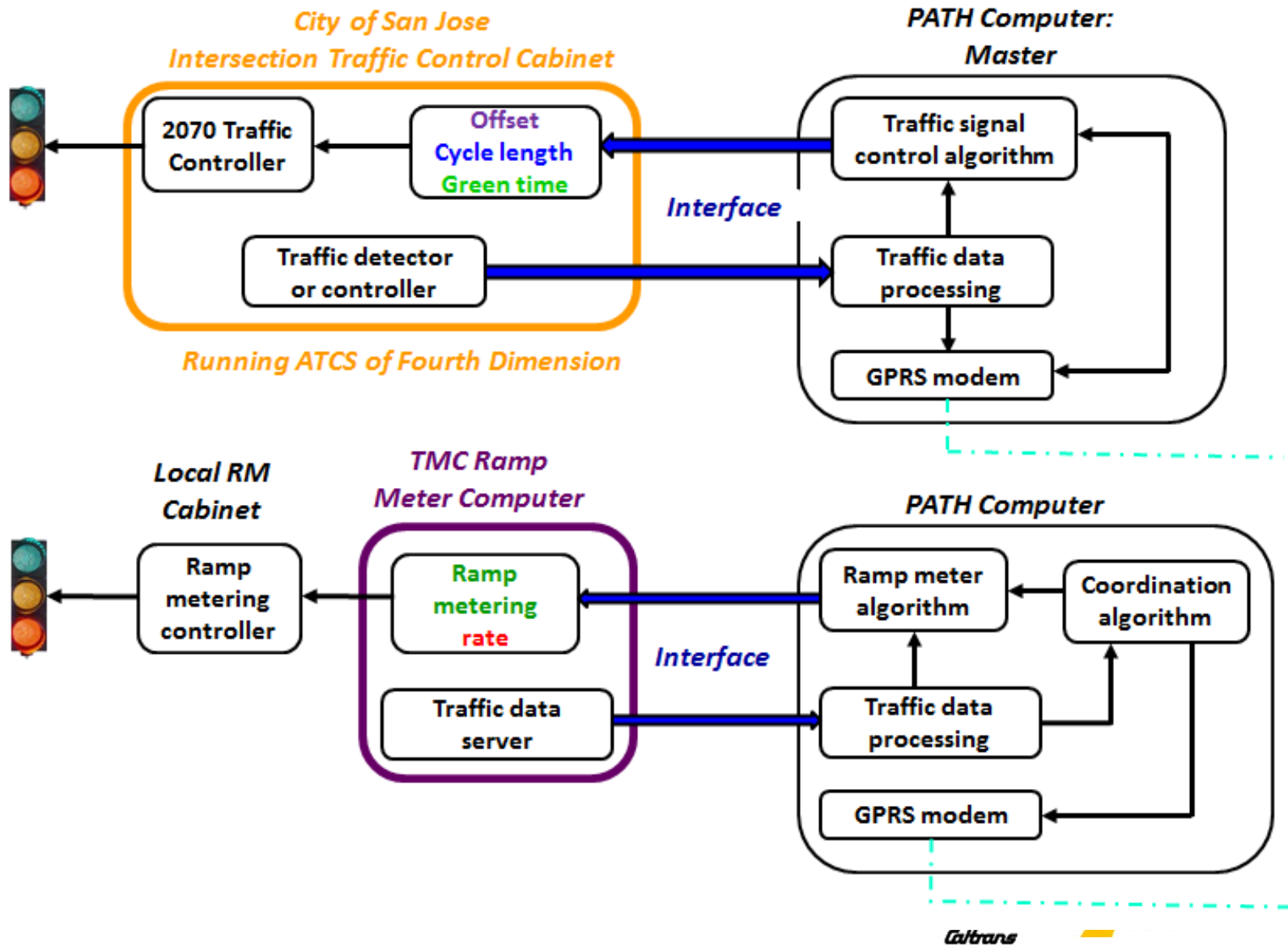
## San Jose Intersection 2070 Controller running Fourth Dimension Software

- **Controller at the following Locations will still run Fourth Dimension firmware**
  - **San Pedro St.**
  - **First Street**
- **Discussed with Tod on 11/17/2011**
- **To send Tod a full set of the parameters we want to set and read;**
- **Tod will modify the Fourth Dimension firmware to accept a specially formatted Ethernet packet formatted with those parameters and apply them using his software;**
- **He will send us the firmware and we should load it into a 2070 for testing provided that San Jose Transportation agree to do so.**

# San Jose Intersection 2070 Controller running Fourth Dimension Software



# San Jose Intersection 2070 Controller running Fourth Dimension Software





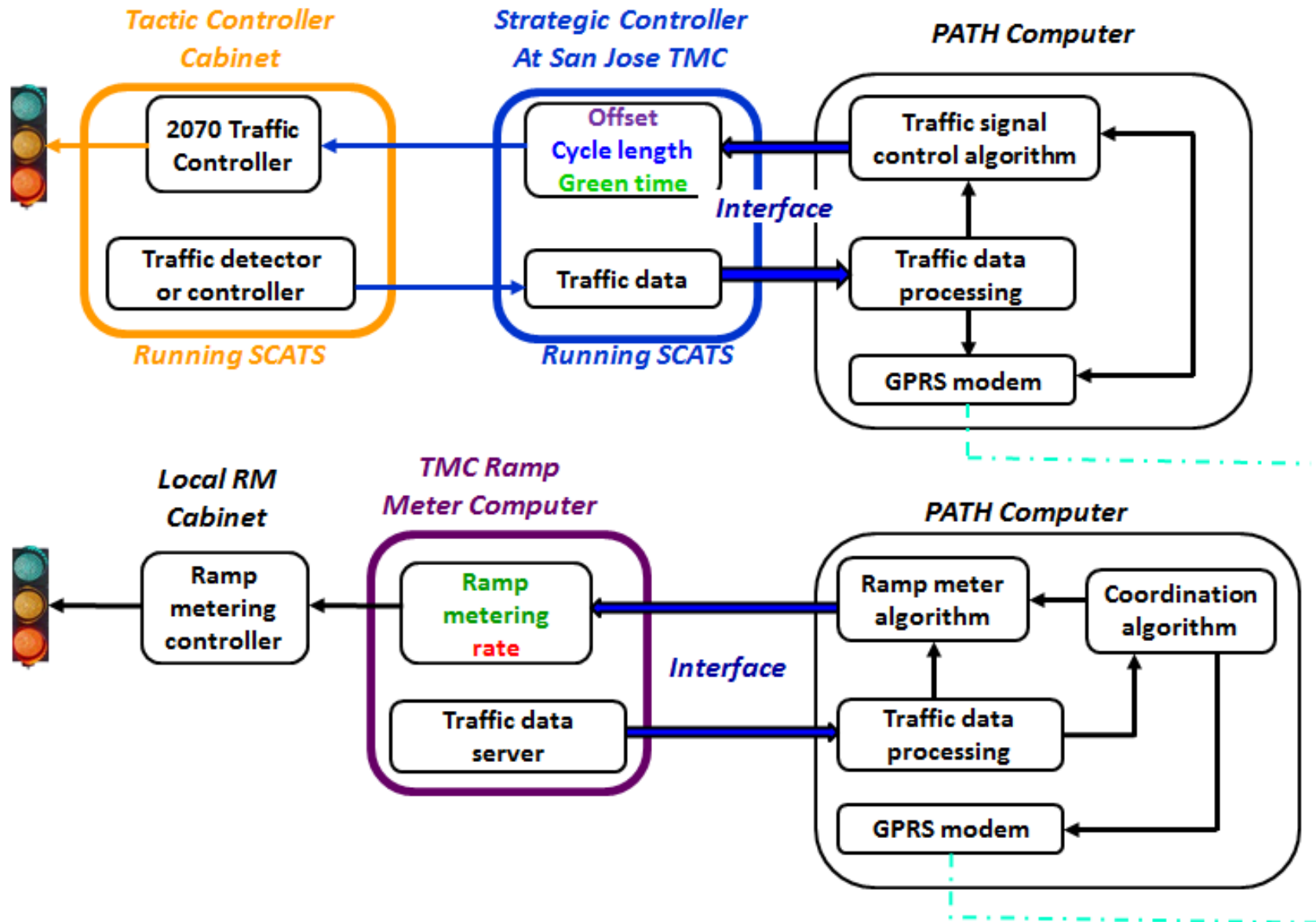
## San Jose Intersection 2070 Controller running SCATS

- **SCATS has 2 control levels: *Strategic Level* at TMC and *Tactic Level* at local control cabinet. It is feasible to dynamically assign the Green Distribution for an intersection from the Strategic Level at TMC;**
- **According to Lily (05/22/12):**
  - **Implementation of ATCS in San Jose is limited to 52 intersections in the City, not city-wide;**
  - **I280-Saratoga intersections will run SCATS in this summer;**
  - **Lily has arranged an engineer to find out how the traffic is controlled at San Pedro and First Street (upstream from CA 87 on Taylor)**





# San Jose Intersection 2070 Controller running SCATS





## Traffic Signal Control Interface with 2070 Controller

- **AB3418: what is it?**
  - **Assembly Bill No. 3418 is intended to facilitate the coordination of traffic signals operated by different jurisdictions.**
  - **The AB 3418 standard protocol supports remote control and monitoring functions only.**
  - **The control function is to enable the maintenance of signal coordination with adjacent intersections.**
  - **The monitoring function is to allow verification of controller operation.**



## Traffic Signal Control Interface with 2070 Controller

- The AB 3418 standard protocol does not provide comprehensive support of all control functions, including uploading and downloading.
- The AB 3418 standard protocol does not replace or supersede existing communications protocols.
- The AB 3418 standard protocol may coexist in a controller with any proprietary or otherwise non-standard protocol.



## Traffic Signal Control Interface with 2070 Controller

- **What we can do with AB3418 Protocol: Due to NTCIP (National Transportation Control/ITS Communications Protocol), AB3418 Implementation Committee limited the Protocol Messages Set to:**
  - **To controller -**
    - **Current day, date, and time to be used to set the controller's clock.**
    - **The number of a locally stored coordination timing pattern (or free, flash, or**
    - **standby mode) to be operated.**
  - **From controller -**
    - **The number of the current coordination pattern (including free or flash).**
    - **The local cycle zero point.**
    - **Any current alarms (e.g. detector fault, flash, preempt, etc.).**
    - **The current green status of up to eight phases.**



## Traffic Signal Control Interface with 2070 Controller

- **CTNET Field Protocol Specification - AB3418 Extended (AB3418E)**
  - **Change maximum and minimum green time**
  - **Change offset**



## Further Consideration for Interface with 2070 Controller

- If AB3418 only allows us to change
  - **Minimum**
  - **maximum green**
  - **Offset**

for each phase, what we can do for coordination project?

Is it adequate for control and coordination purposes?