

Peer-To-Peer Econolite Applications

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Enhancing Traffic Flow: The Power of Peer-to-Peer Messaging in Traffic Signals

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What is Peer-To-Peer (P2P) Communication?

- Communication between two or more Traffic Signals
- Allows a traffic signal to "see" what is going on at another intersection
- Communications between signals is through Logic Statements
- Controllers send out small packets of information to trigger actionable responses – On the Fly Decisions



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When To Use Peer-To-Peer

- Two or more closely spaced intersections that need to be "coordinated" so vehicles don't stop multiple times
- Want to operate intersections as "Free"
- No other traffic signals on system near-by
- Constantly changing traffic patterns and volumes

 Construction, Schools, Commercial, Weekend,
 Events
- Diamond intersections with two controllers No Cables between
- Need to operate an advanced warning flasher or other device



Across agency coordination



Benefits Overview – Why We Use It

- Active response to changing traffic conditions
- Plan traffic sequences and duration
- Adapts to present conditions
- Reduce congestion
- Crash reduction
- Reduce Emissions
- Minimize need to develop and maintain
 Coordinated timings Set it and Forget it
- Save Staff and Consultant Resources





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What is needed?

- Established Communications
 - LTE Router 809 or 1101 AT&T or First Net (TBD)
 - WER's
 - Ethernet Hard Wire Connection
- Controller with Peer-to-Peer
- Unique IP Address for each cell router with correct port forwarding rules
- Central Signal Management System (Optional)





How It Works

| C EOS Front Panel US 90 @ SH 211 EB - 10.135.9.46 _ C | - x |
|--|-----|
| PEER TO PEER BETUP PEER TO PEER BETUP 1 503 10.135, 0.4 25 2 503 10.135, 0.4 25 3 503 0.0, 0.0 1 4 503 0.0, 0.0 1 5 503 0.0, 0.0 1 5 503 0.0, 0.0 1 6 503 0.0, 0.0 1 1 503 0.0, 0.0 0 1 503 0.0, 0.0 0 | |

Configure all Controllers to Shared Network

•

Unique IP Addresses for each cell router
Requires opening Port 503 on Router

Step 1

| EOS Front Panel US 90 @ SH 211 EB - 10.13 | 5.9.46 |
|---|------------------|
| | |
| | |
| | |
| | |
| STATUS (CABINET FREE 1 1) | 1/16/24/11.58.28 |
| entres (capital rans) ra | 110/21/11.00.20 |
| 12345678 9012345 | 56 4 MGRN1 3 |
| PH STATG | MAX1 26 |
| | |
| | |
| VEH OVLP RR | |
| | EVENT DT 2 |
| CRD DTN 2 CVC 05/ 0 | TIMINC 1 |
| | SEQUENCE 2 |
| 12345678 90123456 | 5 DETECTOR PL 1 |
| TSP/SCP | - SCP STR 1 |
| PREEMPT | |
| LP FLAG X | SOURCE TBC |
| TP ADDR: 10.2.1.101 | SYS CMD ETH |

Configure Controllers

Assign each controller/device as a Peer with others
Verify communication status on controller or using simple logic

Step 2

statement



Assign Functions

True or False Logic Statements
What you want controller to receive or check at peer
What does it do with it receives info



US 90 and SH 211 – Diamond

• Goals:

- Operate diamond with two separate controllers.
- Minimize stops for southbound leftturns (1,700-2,000 in AM peak)
- **Execution:** Install two cabinets/controller with comms and CCTVs and Restriped bridge to two lanes southbound and one lane northbound
- **Challenges:** Phasing of Northbound Leftturn (Lead or Lag) with shared leftturn/through lane





- Statement 1: Peers check to make sure other signal is operating (Not in Flash or Stop time
- Peer 1 (southern intersection): Holds Southbound left-turn green until 20 seconds after southbound through at northern intersection
- Peer 2 (northern intersection): Holds Northbound through until after southbound left goes yellow.
- Effect: Intersections are "Free" and cycle lengths automatically float based on traffic volumes. No time-of-day plans to maintain!



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SH 211 & US 90



SH 46 (Bulverde)

- Goal:
 - Coordinate four intersections with each other to avoid traffic congestion
 - Adapt to traffic conditions during school peak hours, weekday, weekend, and construction activities
- **Execution:** Develop logic statements for P2P conversations to happen
- **Conclusion:** With controllers in communication, a green band now exists reducing congestion and travel time along the corridor.



SH 46 (Bulverde)



| Peer Message Statements: | P 3 P 2 Singing Oaks | P | SH 46 N |
|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|
| PEER 4: 10.2.1.104 | PEER 3: 10.2.1.103 | PEER 2: 10.2.1.102 | PEER1: 10.2.1.101 |
| 1: IE 1E VEH OVERI AP GREEN 1 IS ON | 1: IE 1E VEH OVERI AP GREEN 1 IS ON | 1: IE 1E VEH OVERI AP GREEN 1 IS ON | 1: IE 4E CTR ON PHASE CALL 3 IS ON |
| AND –F LP FLAG 1 IS ON | AND –F LP FLAG 1 IS ON | AND –F LP FLAG 1 IS ON | OR 4F CTR ON PHASE CALL 4 IS ON |
| THEN CTR HOLD PHASE 2 IS ON | THEN CTR HOLD PHASE 2 IS ON | THEN CTR HOLD PHASE 2 IS ON | OR 4F CTR ON PHASE CALL 7 IS ON |
| | | | OR 4F CTR ON PHASE CALL 8 IS ON |
| | | | THEN LP SET LOGIC FLAG 1 ON |
| | | | ELSE LP SET LOGIC FLAG 1 OFF |
| 2: IF 1F VEH YELLOW ON PH 2 IS ON | 2: IF 1F VEH YELLOW ON PH 2 IS ON | 2: IF 1F VEH YELLOW ON PH 2 IS ON | 2: IF 4F LP COB CODE OFF 384 |
| AND F LP FLAG 1 IS ON | ANDF LP FLAG 1 IS ON | AND F LP FLAG 1 IS ON | OR 4F LP COB CODE OFF 385 |
| ANDF CTR PHASE TIMING 2 IS ON | ANDF CTR PHASE TIMING 2 IS ON | AND F CTR PHASE TIMING 2 IS ON | AND 4F VEH GREEN ON PH 2 IS ON |
| AND F CTR PHASE TIMING 6 IS ON | ANDF CTR PHASE TIMING 6 IS ON | AND F CTR PHASE TIMING 6 IS ON | ANDF LP FLAG 4 IS ON |
| THEN | THEN | THEN | THEN CTR HOLD PHASE 2 ON |
| CTR SET FO RING 1 ON | CTR SET FO RING 1 ON | CTR SET FO RING 1 ON | |
| CTR SET FO RING 2 ON | CTR SET FO RING 2 ON | CTR SET FO RING 2 ON | |
| 3: IF 1F LP CIB CODE OFF 185 | 3: IF 1F LP CIB CODE OFF 185 | 3: IF 1F LP CIB CODE OFF 185 | 3: IF 4F LP CIB CODE OFF 185 |
| AND 1F CTR STOP TIME RING 1 IS OFF | AND 1F CTR STOP TIME RING 1 IS OFF | AND 1F CTR STOP TIME RING 1 IS OFF | AND 4F CTR STOP TIME RING 1 IS OFF |
| AND 1F LP CIB CODE OFF 227 | AND 1F LP CIB CODE OFF 227 | AND 1F LP CIB CODE OFF 227 | AND 4F LP CIB CODE OFF 227 |
| THEN | THEN | THEN | |
| CRD SET FREE ON | CRD SET FREE ON | CRD SET FREE ON | THEN CRD SET FREE ON |
| LP SET LOGIC FLAG 1 ON | LP SET LOGIC FLAG 1 ON | LP SET LOGIC FLAG 1 ON | LP SET LOGIC FLAG 4 ON |
| ELSE ODD OFT FORF | ELSE | ELSE | 5105 000 057 5055 |
| UN DELAY SOD | UN DELAY SOD | UND SET FREE UN | ELSE UKD SET FREE UN |
| CPD SET EPEE OFF | CPD SET EPEE | CPD SET EPEE OFF | LP DELAT FOR 5.0 SECONDS |
| | | | |
| LF SET LOUIC FLAG I OFF | LF SET LOUIC FLAG I OFF | LF SET LOUIC FLAG I OFF | UND SET FREE UFF |

4: IF 1F TOD HOUR

THEN

AND 1F TOD MINUTE

AND 1E TOD SECOND IS

IS

IS

TOD SET TIME RESET ON

3

29

59

4: IF 1F TOD HOUR

AND 1F TOD MINUTE

AND 1E TOD SECOND

THEN

IS

IS

IS

TOD SET TIME RESET ON

3

29

59

- Statements 3 and 4: Check to make sure all intersections operational and clocks are synced
- Peer 2&3 (Middle Intersections): Holds arterial green until EB through at diamond goes yellow
- Peer 4 (West intersection):
 Holds arterial green until EB
 through at diamond goes yellow
- Peer 1(Diamond): Holds EB arterial green until WB through at Windmill goes yellow
- Effect: Cycle length set automatically by traffic at US 281 Diamond or Windmill Ranch. Intersections in the middle are simultaneous yellow.

SH 46 (Bulverde) Logic Statements

4: IF 1F TOD HOUR

THEN

AND 1F TOD MINUTE

AND 1F TOD SECOND

IS

IS

IS

TOD SET TIME RESET ON

3

29

59





US 281 and Mustang Vista

- **Goal:** Coordinate RCUT U-turn and Mustang Vista intersection. Reduce crashes happening between the intersections.
- **Execution:** Add P2P forces U-turn off when there is a car at either the u-turn or at Mustang Vista. Holds vehicle back at U-turn so they are not stored between intersections

• Challenges/Refinements:

- Communication Failures Need one back up coordination plan
- Added "Be Prepared to Stop" advanced warning flasher prior U-turn to warn drivers when signal will go yellow



Visual Example



| | G | P1 | P 2 |
|---|---|--|--|
| | US 281 SB 1 | o NB Turnaround | Mustang Vista |
| | | | |
| PEER 1: 10.135.6.202 | PEER 1 TALKING TO PEER 2 SUMMARY | PEER2: 10.135.3.214 | PEER 2 TALKING TO PEER 1 SUMMARY |
| LP #1:1 72 F U CIB CODE OFF 185 AND 22 FC RSTOP TIME RING 1:5 OFF AND 22 FC RSTOP TIME RING 1:5 OFF 227 THEN CRD SET FREE ON LP SET LOGIC FLAG 1 ON ELSE LP SET LOGIC FLAG 1 OFF | IF PEER 2 CLOCAL FLASH IS OFF STOP TIME IS OFF THEN FEET IN UN OFF THEN FEET IN UNTYTEN FRAMMERE AND WILL DISPLAY ALOGIC FLAG ON STATUS SCREEN TO NOTIFY PEER 2 THAT PEER 1 HAS REACTED TO THE MESSAGE IF ONE OUT OF THE 3 STATEMENTS IS ON IN PEER 2 PEER 1 WILL NOT RUM FREE AND WILL NOT RECORD | IP #1: IF IP CIB CODE OFF 185 AND IF CRTS TOT MER NING 15: OFF AND IF CRTS TOT MER NING 15: OFF Z27 THEN CRD SET FREE CIT SET CHAIL ON LP SET LOGIC FLAG 1 ON ELSE LP SET LOGIC FLAG 1 OFF | IF PEEN 1 • LOCAL FLASH IS OFF • STOP TIME IS OFF • MINIMUM RECALL IS OFF PEEN 2 RUN FREE BACKGROUND CYCLE SET TO NON-ACTUATED DISPLAY LOGIC FLAG 1 ON START PEDESTRAIN RECYCLE IN RING 1 |
| | LOGIC FLAG ON SCREEN | | |
| AND 2F CTR ON PHASE CHECK 1 IS ON THEN CTR CALL PHASE 3 ON LP SET LOGIC FLAG 2 ON ELSE LP SET LOGIC FLAG 2 OFF | A CONTROLER SEES "PHASE 1" BEING ON THEN CONTROLER IN PERE 1 WILL TURN "PHASE 3" ON AND WILL DBYALU GGIC FASE O 20 NTAUS SCREEN TO INDICATE MESSAGE WAS RECIEVED IF STATEMENT IS OFF, THEN PERE 1 WILL NOT RECORD UP FAGE 20 NTAUS SCREEN AND WILL NOT TURN PHASE 3 ON | AND 1F VEH OVERLAP YLW 5 IS OFF THEN CTR HOLD PHASE 2 ON LP SET LOGIC FLAG 2 ON ELSE CTR HOLD PHASE 2 OFF LP SET LOGIC FLAG 2 OFF | AND PEER 1 "OVERLAP E" YELLOW TRAILING GREEN ENDS THEN SWITCH ON PHASE HOLD FOR PHASE 2 AND SHOW LOGIC FLAG 2 ON SWITCH OFF HOLD ON PHASE 2 AND REMOVE LOGIC FLAG 2 IF OVERLAP YELLOW IS ON |
| LP #3: F2 CTR PH NEXT ON PHS LIS ON OR 72 VER GREEN ON PH LIS ON AND-FLP FLAG LIS ON THEN CTR CALL PHASE 4 ON CTR HOLD PHASE LP SET LOGIC FLAG 3 ELSE LP SET LOGIC FLAG 3 | IF PER 2 CONTROLLER (MUSTANG VISTA) HAS A "N" (MENT) CALL ON PHASE 1 OR "O" GREEN ON PHASE 1 IN STATUS SCREEN AND PER 1 (BOSH TUNNAROUND) FAG 15 ON THEM CONTROLLER IN PER 1 WILL TUNN PHASE 4 ON HOLD PHASE 4 AND DISPLAY LOGIC FLAG 3 ON THE STATUS SCREEN TO INDICATE MESSAE WAS RECEVED INDICATE MESSAE WAS RECEVED IN CALL TO A THE STATUS SCREEN TO INDICATE MESSAE WAS RECEVED | | |
| LP #4: IF -F VEH GREEN ON PH 2 IS OFF | IF PEER 1 GREEN LIGHT FOR PHASE 2 IS OFF | | |
| THEN CTR SET TEST A-E 1 ON SIG SET PH PED CLR 2 ON ELSE CTR SET TEST A-E 1 OFF | THEN CONTROLLER TO SWITCH ON INPUT PIN TEST A AND BEGIN THE PEDESTRAIN CLEARNACE OUTPUT FOR PHASE 2 | | |
| SIG SET PH PED CLR 2 OFF | IF PEER 1 GREEN LIGHT IS ON, THEN SWITCH OFF INPUT TEST A AND END PEDESTRAIN CLEARANCE FOR PHASE 2 | | |



US 281 & Mustang Vista



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IH-35 and FM 306 Partial DLT

- **Goal:** Operate the Partial DLT as a single intersection for driver expectancy
- **Execution:** Criss-Cross intersection is virtually tied to main intersection only allows the left-turns to go when the main intersection will be green
- Challenges:
 - Displaced Left-turn Signal Plans included multiple controllers (Main diamond & Criss-Cross)
 - City Operated intersection within 450 feet of Criss-Cross
 - Buc-ee's and Large Commercial Development (Target, Dicks, Cinema, 20+ Restaurants)
- Conclusion:
 - First 3 months were challenging with new operation. Since then, no complaints
 - Multiple cycle delays reduced to a single cycle on all approaches



IH-35 and FM 306 Partial DLT



Peer 2: Left-turn Green starts 10 seconds before Northbound Frontage Road goes yellow.

Effect:

No Traffic stored between the intersections. Once vehicles get Green on outside movements they make it through the entire system without stopping!

Reduces crashes and improve operations



Peer-2-Peer Improvements In Texas!



Location: IH-10 & Woodlawn & Fredericksburg **Propose:** Peer-2-Peer for two Diamond and one intersection operation using 3 controllers

W = Diamond Operation

= Intersection Operation



Location: IH-35 & FM 1518 & Evans Rd **Propose:** Peer-2-Peer for two Diamond operations using 2 controllers

Location: US 281 & FM 1863 & Wiley Rd **Existing:** Peer-2-Peer for one Diamond operation with T-intersection using 2 controllers



Challenges and Lessons Learned

- New Modems and Security
- IP addresses on controllers in Centracs vs. Router
- Communications will fail! Add fallback coordination plans to keep intersections coordinated
- Intersections will go into flash for other reasons Make sure the first statement checks the other signal is operational or it can cause infinite holds
- Test, Test, Test!
- Adjustments will be needed once implemented
- 72-hour rule If is it not working you will hear about it. Be Prepared to respond



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